VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

STREAM IMPACT AND COMPENSATION ASSESSMENT MANUAL

January 6, 2006

Stream Assessments

Stream Impacts

Stream Compensation

DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

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Acronyms

RCI	Reach Condition Index
SQF	Stream Quality Factor
CR	Compensation Requirement
IF	Impact Factor
L_I	Length of Impact
DA	Drainage Area
CC	Compensation Credit
A_F	Adjustment Factors
L_C	Length of compensation reach
A_F	Adjustment Factor

Forms

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Introduction

The purpose of this Manual is to describe a method to rapidly assess the stream compensation requirements resulting from permitted stream impacts, and the amount of “credits” obtainable through implementation of various physical compensation practices. The Manual describes a process to: 1) assign a quality value to the stream to be impacted; 2) assess the type or severity of impact; 3) determine the compensation requirement in linear feet; and, 4) determine what types of and the amount of the various compensation practices that will satisfy the compensation requirement. Projects requiring stream compensation permitted under the Virginia Department of Environmental Quality’s (DEQ) Virginia Water Protection Permit (VWPP) Program may be evaluated in the manner described in this Manual. However, this Manual does not supercede State Water Control Law or VWP regulation regarding the sequencing of mitigation alternatives. This Manual is to be applied statewide, and is for use in wadeable perennial and intermittent streams. Implementing this method will provide consistency and predictability for the applicants and agency personnel. This method does not take the place of project specific review and discussion, which may result in adjustments to the compensation requirements or credits obtained through application of this process. This method can be applied to stream compensation projects performed on-site, off-site, for a stream bank, or for an in-lieu fee fund project, thereby ensuring a standard application for evaluating and crediting all stream compensation projects.

This Manual was produced following several meetings of DEQ’s Stream Mitigation Advisory Workgroup, and incoporates much of the input received from the Workgroup as well as DEQ staff. The Workgroup was composed of representatives from the state and federal regulatory and advisory agencies, the consultant and banker community, the Virginia Department of Transportation (VDOT), local governments, academic institutions, and non-profit organizations. The overall formatting and the flowcharts in Appendix B are based on Wetland Studies and Solutions, Inc. Virginia Stream Impact Assessment Manual (Version 1.2).

This Manual is divided into five sections, summarized below. The sections represent the basic types of analyses that are performed, including the assessment of existing conditions, assessment of proposed impacts, determination of compensation requirements, and assessment of the value of proposed compensation projects.

Section 1 - “Stream Impact Site Assessments” describes a method that will enable the user (refered to as the “Evaluator”) to rapidly assess and assign a value to a stream reach proposed to be impacted. Several examples are provided (including photographs) as a reference to guide the Evaluator during the assessment process.

Section 2 - “Impact Type Assessment for Stream Impact Site” presents a procedure for quantifying proposed impacts to a stream.

Section 3 - “Determining Stream Compensation Requirements” explains the method for calculating the linear feet of compensation required for the project. The factors used in this calculation are the stream assessment “value” (Section 1), the type of impact proposed (Section 2), and the linear feet of impact. The result is the total compensation requirement in linear feet.

Section 4 - “Fulfilling Compensation Requirements” explains the various methods by which stream impacts may be compensated through implementation of the various compensation practices. It also explains the process of reviewing stream compensation plans to determine the appropriate credit.

Section 5 - “Determining Adjusted Stream Compensation Credit” explains the method for calculating the linear feet of credit obtained after review of stream compensation plans. The factors used in this calculation are the credit ratio (Section 4), linear footage of the compensation stream, and any applicable adjustment factors (Section 4).

The following page presents an outline of the processes explained in these five sections, which can be used as a summary of the method presented in this Manual. In addition, DEQ has provided an Excel file on it's website to aid the Evaluator in three ways:

1) The Evaluator may input the linear feet of impact to a single assessment reach. Excel then automatically calculates the linear feet of compensation required, using all possible combinations of stream assessment "value" and type of impact. It also calculates the linear feet needed from any of the compensation practices to fulfill the compensation requirement.

2) The Evaluator may input the informatin required for Section 3. Excel then automatically calculates the linear feet of compensation required for an entire project. It also calculates the linear feet needed from any of the compensation practices to fulfill the compensation requirement.

3) The Evaluator may input the linear feet of compensation required for an entire project, expected credit ratio, and applicable Adjustment Factors to obtain the linear feet needed from a particular site to fulfill the compensation requirement.

Applicants should find this a valuable tool in planning their compensation site search and alternatives (e.g., restoration, enhancement, or preservation).

Outline of Stream Impact and Compensation Assessment Methodology

Step 1 – Stream Impact Site Assessments

- Determine Length of Assessment Reach
- Determine Type of Assessment to Perform
  - Man-Made Channel
  - Natural Channel
- Perform Assessment
  - If Man-Made Channel → Record assigned Stream Quality Factor (**SQF**) on Form 1 and proceed to Step 2
  - If Natural Channel → Obtain RCI from Flow Charts
- Obtain Stream Quality and Stream Quality Factor (**SQF**) from Table 3
  - Severe = 1.0
  - Poor = 1.1
  - Marginal = 1.2
  - Suboptimal = 1.3
  - Optimal = 1.5
  - Exceptional = 1.6

Step 2 – Impact Type Assessment for Stream Impact Site

- Obtain Impact Factor (**IF**) from Table 4
  - Severe = 1.0
  - Significant = 0.75
  - Moderate = 0.5
  - Negligible = 0

Step 3 – Determine Stream Compensation Requirements

- Calculate Equation 1
  - Compensation Requirement (**CR**) = Length of Impact ($\mathbf{L_I}$) × Stream Quality Factor (**SQF**) × Impact Factor (**IF**)

Step 4 – Fulfilling Compensation Requirements

- Determine Compensation Category
  - Restoration
  - Enhancement Level II
  - Enhancement Level I
  - Preservation
- Determine Credit Ratio for Compensation Category
  - Restoration = 1.0 : 1
  - Enhancement Level II = 1.5 – 2.25 : 1
  - Enhancement Level I = 3.0 – 3.75 : 1
  - Preservation = 5.0 – 20.0 : 1
- Apply Applicable Adjustment Factors ($\mathbf{A_F}$)
  - Riparian Buffer = -0.5, -0.2, 0.0, 0.1, 0.2, 0.3
  - Watershed Restrictions = 0.0, 0.4
  - Rare, Threatened, and Endangered Species or Communities = 0.0, 0.2
  - Community Related Constraints = 0.0, 0.5
  - Livestock Exclusion = 0.0, 0.3
- Apply Hydrologic Unit Code Factor to the Compensation Requirement (CR)
  - Hydrologic Unit Code = 1.0, 1.5

Step 5 – Determine Adjusted Stream Compensation Credit

- Calculate Equation 2
  - Adjusted Compensation Credit (**Adjusted CC**) = [Length of Compensation Reach ($\mathbf{L_C}$) ÷ Credit Ratio] × [1.0 + (sum of Adjustment Factors($\mathbf{A_F}$))]

Steps 1 through 5 allow both applicants and agency personnel to determine the stream compensation requirement resulting from stream impacts and to determine the adequacy of a stream compensation proposal for satisfying those requirements.

1.0 Stream Impact Site Assessments

Impacts are proposed in streams of various conditions or qualities. It is therefore important to assess the quality of the stream reach being impacted and use that as a factor in determining **Compensation Requirements (CR)**. There are numerous methodologies that arrive at a numerical index to use as an indicator of stream quality. **The methodology described in this section was developed for use in the regulatory process for the purpose of determining stream compensation requirements for impacts.** It is a simple, quick, and cost-effective method that is easy to understand, and requires little training. It does not substitute for more detailed stream studies that may be undertaken to determine stream quality or biological conditions for other purposes.

The proposed stream to be impacted is assessed to determine its current condition or quality. The Stream Assessment Field Form (Form 1), included in Appendix A, is used to record assessment information for each individual assessment reach (one form per assessment reach). Each stream impact project may need to be divided into multiple assessment reaches. Before performing the assessment, the Evaluator must determine the appropriate length of each assessment reach. The length of the assessment reach may be any length, but is determined by significant changes in one or more of the four Parameters, described in the Natural Channel Assessment Methodology in Section 1.2. For example, if the length of impact ($\mathbf{L_I}$) for the site is 1000' and the **In-Stream Habitat** is *Poor* for 500' and *Optimal* for 500', then two Stream Assessment Field Forms (Form 1) are completed.

The assessment is conditioned on whether the stream is "man-made" or "natural," as differentiated in the Man-Made Channel Assessment Section 1.1. If the stream length to be impacted ($\mathbf{L_I}$) contains both man-made and natural reaches, then they are to be assessed individually. For example, if your $\mathbf{L_I}$ is 500' long and includes a 50' section of concrete pipe, then the 50' section of concrete pipe is assessed using the Man-Made Channel Assessment and the remaining 450' is assessed using the Natural Channel Assessment Methodology. The results of the assessments for both man-made and natural channels are recorded in Sections A & B, respectively, of the Stream Assessment Field Form (Form 1).

The Stream Assessment Field Form (Form 1) is divided into the following four sections, which summarize how the form is completed.

Section A is used for man-made channels. The Stream Quality Factor (**SQF)** listed adjacent to the type of lining is selected and recorded in Section C. This ends the assessment process for man-made channels.

Section B is used for all assessment reaches other than man-made channels. The Parameter Condition within each of the four Parameters is determined, following the procedures presented in Sections 1.2.1 - 1.2.4, and recorded under Section B on the form.

Section C provides a space to record the Reach Condition Index (**RCI)**, determined from Section A for man-made channels or from the flowcharts contained in Appendix B for natural channels. It also provides a space to record the *Stream Quality* and its corresponding **SQF**, determined from Table 3 in Section 1.4.

Section D notes that representative photographs of the assessment reach must be taken, properly labeled, and submitted with Form 1. Space is also provided for field notes pertaining to the assessment reach.

Appendix E is provided for the Evaluator to use as a Field Guide. It is a condensed version of the method and descriptions contained in Sections 1.1 through 1.4 of this Manual, and also contains a copy of the Stream Assessment Field Form (Form 1). An experienced Evaluator who is thoroughly knowledgable of this Manual should only need the Field Guide in Appendix E to perform stream impact site assessments on their project. The Evaluator may also choose to use the Flow Charts in Appendix B.

1.1 Man-Made Channel Assessment

Man-made channels are those that have been physically altered by man to such a degree that they no longer support many of the natural functions of a stream channel. There are two general types of man-made channels: culverts and open channels.

A culvert system completely removes a stream from its natural environment, eliminating any natural functions that may have once existed. The lowest Stream Quality Factor (SQF) of 0 is therefore applied to all culvert systems except bottomless culverts. Bottomless culverts are assessed using the Natural Channel Assessment Methodology described in Section 1.2.

Open channels are typically straightened, widened, and lined with concrete, gabions, concrete blocks, or riprap. Although, still connected to its environment, many of the natural functions of the stream are extremely impaired. Each of these types of channels is treated separately. Channels lined with a concrete bottom automatically receive a SQF of 0.25 in Section A of the Stream Assessment Field Form (Form 1). Channels lined on the bottom with gabions or concrete blocks automatically receive a SQF of 0.5 in Section A of the Stream Assessment Field Form (Form 1).

Channels that have a concrete or gabion bottom but have “naturalized” over time through sediment deposition and/or re-vegetation are assessed using the Natural Channel Assessment Methodology described in Section 1.2. Channels lined on the bottom with riprap are also assessed using the Natural Channel Assessment Methodology. Channels that do not have a hardened bottom are assessed using the Natural Channel Assessment Methodology.

The following summarizes the application of man-made channel assessments and when to apply the Natural Channel Assessment Methodology:

MAN-MADE CHANNEL ASSESSMENT

1.	Culverts (except bottomless)	→	SQF = 0
2.	Open Channel with concrete bottom	→	SQF = 0.25
3.	Open Channel with gabion or concrete block bottom	→	SQF = 0.5
4.	Open Channel with riprap bottom	→	Apply Natural Channel Assessment Methodology
5.	Open Channel without a hardened bottom	→	Apply Natural Channel Assessment Methodology
6.	Naturalized, Man-Made Channel	→	Apply Natural Channel Assessment Methodology

The following page provides example photographs of when to apply the Man-Made Channel Assessment versus when to apply the Natural Channel Assessment Methodology.

Culverted Stream Channel

SQF = 0

Open Channel with Concrete Bottom

SQF = 0.25

Open Channel with Riprap

Apply Natural Channel
Assessment Methodology

Open Channel without Hardening <u>OR</u>
Naturalized Man-Made Channel

Apply Natural Channel
Assessment Methodology

1.2 Natural Channel Assessment Methodology

The basis of the Natural Channel Assessment Methodology is the review of the following four categories of stream characteristics (referred to as Parameters): **Channel Condition**, **Riparian Buffer**, **In-Stream Habitat**, and **Channel Alteration**. The assesment methodology is designed so that a stream can be assessed using a 'snapshot in time' approach. Analysis and/or assumptions about past activities or conditions are not needed. Each of these Parameters are subdivided into various levels of Parameter Conditions, whose descriptions may incorporate references to long term observation, to be used for additional information purposes only. The Parameters and various levels of Parameter Conditions are depicted below.

Parameter Conditions associated with each Parameter

Channel Condition	Riparian Buffer	In-Stream Habitat	Channel Alteration
Severe	Poor	Poor	Severe
Poor	Marginal		Moderate
Marginal		Marginal	
Suboptimal	Suboptimal		Minor
Optimal	Optimal	Optimal	Negligible

Each of the four Parameters (**Channel Condition, Riparian Buffer, In-Stream Habitat**, and **Channel Alteration**) are explained in detail in Sections 1.2.1 – 1.2.4. Definitions and examples for each of the Parameter Conditions are also provided in each section. To evaluate an assessment reach, evaluate each of the four Parameters independently and select the Parameter Condition that best describes the actual stream conditions observed in the field. Record the selected Parameter Condition in the corresponding category in Section B on the Stream Assessment Field Form (Form 1). After each of the Parameters have been evaluated and the appropriate Parameter Conditions have been selected and recorded on the Stream Assessment Field Form (Form 1), refer to the appropriate **RCI Flowchart** in Appendix B to determine the resulting **Reach Condition Index (RCI)** for the assessment reach. Then proceed to Section 1.4 to determine the corresponding Stream Quality and **Stream Quality Factor (SQF)**.

1.2.1 Channel Condition

Under most circumstances channels respond to disturbances or changes in flow regime in the following sequential, predictable manner:

Initial downcutting	→	***Over-widening***	→	***Healing***	→	***Establishing new floodplain within channel***

This sequential, predictable manner is the basic premise behind the stream channel evolutionary process in which a stream responds to changes by degrading to a lower elevation and eventually re-stabilizing at that lower elevation. The differing stages of this process can be directly correlated with the current state of stream stability. The purpose of evaluating **Channel Condition** is to determine the current condition of the channel cross-section, as it relates to this evolutionary process, and to make a correlation to the current state of stream stability. The assigned Parameter Condition is generally descriptive of different stages of channel evolution.

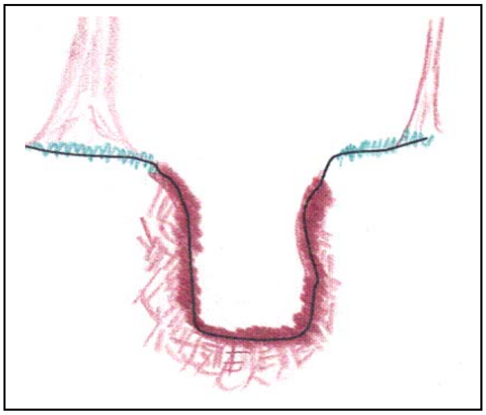
These evolutionary processes, and therefore this Parameter, apply to the majority of stream systems and assessment reaches that the Evaluator will encounter. This is due to the fact that the majority of stream systems are degrading, healing, or stable. A degrading stream is one in which the sediment transport capacity exceeds the sediment supply, or there is insufficient stability present to prevent the streambed from lowering its elevation and/or widening. In contrast, a stream system that is actively aggrading is one in which the sediment supply exceeds the sediment transport capacity and sediment deposition accrues to the point where the channel is filling up. If the Evaluator encounters an aggrading system, or an unstable braided system, the following Parameter Conditions may be difficult to apply. The Evaluator is to use best professional judgment in assigning a Parameter Condition and consult with your agency representative.

A channel's condition can be determined by visually assessing certain geomorphological indicators. These indicators include channel incision, access to original or recently created floodplains, channel widening, channel depositional features, rooting depth compared to streambed elevation, streambank vegetative protection, and streambank erosion. Each of the Parameter Conditions describes a particular combination of the state of these indicators that generally correspond to a stream channel stability condition at some stage in the evolutionary process. While evaluating your assessment reach, determine which Parameter Condition best describes the **Channel Condition** based on the descriptions provided.

Channel Condition Parameter Conditions

The assessment reach is assessed for the condition of the channel using the following five Parameter Conditions. The Evaluator selects the Parameter Condition most representative of the assessment reach. This is recorded in Section B of the Stream Assessment Field Form (Form 1).

Severe



These channels are deeply incised with vertical and/or lateral instability and will likely continue to incise and widen. Incision is severe so that flow is contained within the banks during heavy rainfall events (i.e. the stream does not have access to its floodplain). The streambed elevation is below the average rooting depth within the banks and the majority of both banks are vertical or undercut. Bankfull may be difficult to determine. Vegetative surface protection along both banks is non-existent or minimal (less than 20%), and is insufficient to prevent significant erosion from continuing.

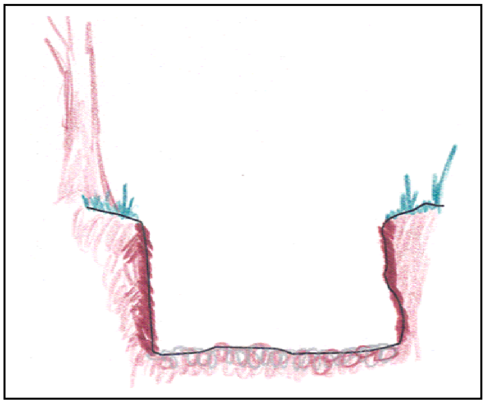
If areas of sediment deposition are present in the channel, they are infrequent, temporary, and highly transient in nature.

-OR-

These channels are aggrading and have an excessive sediment supply that is filling the channel with alluvium, impeding its flow. Multiple thread channels and/or subterranean flow may be present in certain aggrading channels. However, stable multiple thread channels naturally occur in some low-gradient streams and should not be given a *Severe* Parameter Condition.

Note: Portions of the assessment reach that are within a bottomless culvert or bridge automatically receive a Parameter Condition of *Severe*.

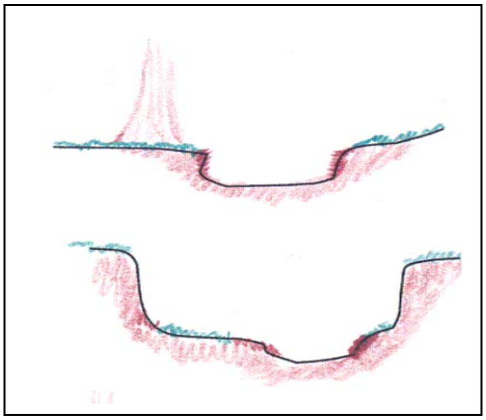
Poor



These channels are not as deeply incised as the *Severe* **Channel Condition**. These channels are also vertically and/or laterally unstable, however they are more likely to widen more so than incise further. The majority of both banks are near vertical with shallow to moderate root depths. Bankfull may be difficult to determine. Vegetative surface protection along both banks is minimal to moderate (20% to 40%), and is insufficient to prevent significant erosion from continuing.

If areas of sediment deposition are present in the channel, they are likely to be temporary and transient in nature, and/or they are contributing to channel instability.

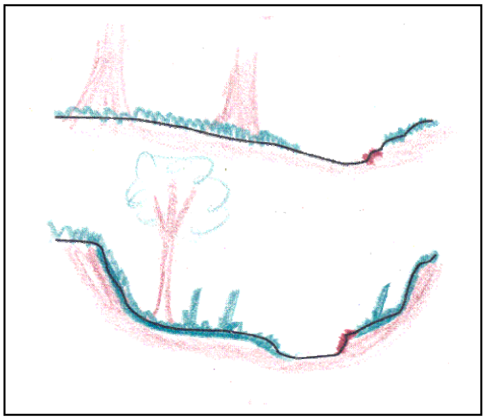
Marginal



These channels are most often incised, but to a lesser degree than the *Severe* and *Poor* **Channel Conditions**. These channels show signs of active erosion or unprotected banks and comparable amounts of stable banks due to flatter slopes and/or vegetative surface protection. The streambanks may consist of some vertical or undercut banks. While portions of the bankfull channel may still widen, other portions have begun to narrow in an attempt to obtain proper dimensions. The channel is attempting to define bankfull and low flow channels (when appropriate for the stream type). Vegetative surface protection is present on one or both banks, but is not continuous. Some vegetative surfaces may be the result of recent bank slumping.

Depositional features (point bars, mid-channel bars, transverse bars, and bankfull benches) are likely beginning to form (when appropriate for the stream type) and some appear to be contributing toward channel stability.

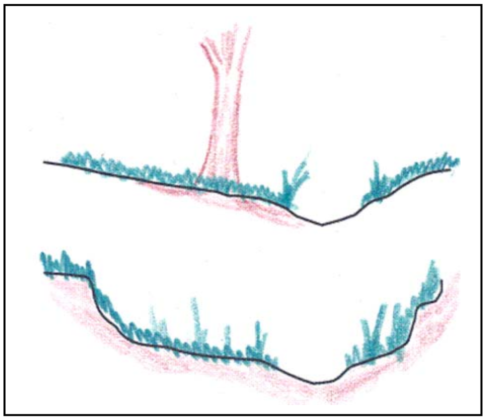
Suboptimal



These channels are slightly incised and contain few areas of active erosion or unprotected banks, but the majority of both banks are stable with vegetative surface protection or natural rock stability present along the majority of both banks. The bankfull and low flow channels (when appropriate for the stream type) are well defined.

Depositional features (point bars, mid-channel bars, transverse bars, and bankfull benches) are likely present (when appropriate for the stream type) and most are contributing to stability. The bankfull and low flow channels (when appropriate for the stream type) are well defined. This stream likely has access to bankfull benches, or newly developed floodplains along portions of the reach.

Optimal



These channels show very little incision and little or no evidence of active erosion or unprotected banks. Vegetative surface protection is prominent along both banks.

Stable point bars and bankfull benches are present (when appropriate for the stream type), however mid-channel bars, and transverse bars should be few. The bankfull and low flow channels (when appropriate for the stream type) are well defined. These channels are stable and have access to their original floodplain or fully developed wide bankfull benches.

1.2.2 Riparian Buffer

Riparian buffers are important to the stream because they perform such functions as: sediment and nutrient removal; streambank stability; organic inputs to aquatic ecosystems; temperature and light regulation; and habitat diversity. The assessment of the **Riparian Buffer** is limited to approximately 100 feet on both sides of the stream throughout the assessment reach, as this is the zone that most directly impacts the aquatic environment and is regulated by other state entities. This Parameter is not intended to be a detailed vegetative cover survey, but instead, is a qualitative evaluation of the cover types that make up the riparian buffer.

The evaluation of the **Riparian Buffer** determines the appropriate Parameter Condition for the assessment reach based on a weighting system that weighs the inner 50' (adjacent to the streambank, from the top of the bank landward) as 60% of the total score, and the outer 50' (50' – 100' from the top of the streambank) as 40% of the total score. The immediately adjacent riparian buffer has a more profound effect on bank stabilization, the aquatic food web, and water temperature moderation than the riparian buffer extending beyond the first 50 feet. Studies[1] have shown that the first 50' filters approximately 60% of the total sediment filtered by a 100' buffer. In addition, draft phosphorous removal efficiencies utilized by the Chesapeake Bay Local Assistance Department[2] imply that the first 50' removes approximately 60% of the total phosphorous removed by a 100' buffer. Most nutrient loading to streams comes from sediment, and increased water temperatures promote increased amounts of phosphorous released from sediments. Review of this information shows a combined effect of the first 50' providing temperature moderation, sediment filtering, and nutrient removal. This information also supports weighing the first 50' at 60% and the outer 50' at 40%. By evaluating the riparian buffer in this manner, it allows the outcome of the **Riparian Buffer** assessment to more accurately reflect this principle. Without assessing the riparian buffer in this manner, a buffer composed of impervious surface on the inner 50' adjacent to the streambank and forest on the outer 50' would score equal to a buffer composed of forest on the inner 50' adjacent to the streambank and impervious surface on the outer 50'. However, these different scenarios would not have equal effects or impacts to the stream.

The Evaluator assesses the inner 50' (0-50') adjacent to each streambank using the Parameter Conditions listed. The Evaluator also assesses the outer 50' (50-100') from each streambank. If the buffer condition varies along the assessment reach, it is rated as an average condition based on the Evaluator's professional judgment. For instance, if the inner 50' adjacent to the right streambank is considered *Poor* for half the distance of the assessment reach and *Suboptimal* for the other half, then it may be appropriate to give it a Parameter Condition of *Marginal* for the entire reach. However, if the difference is significant, then a different Stream Assessment Field Form (Form 1) is completed.

Upon determining the Parameter Condition for both the inner and outer 50' (separately) for the left bank, the Evaluator uses Table 1 to determine the weighted Parameter Condition for the left bank. Find the Parameter Condition for the inner 50' in the appropriate column and the outer 50' in the appropriate row. Where the column and row intersect is the overall Parameter Condition for the left bank. This process is repeated for the right bank.

Note: The left and right banks are determined while facing in the downstream direction.

The Evaluator then uses Table 2 to determine the overall Parameter Condition for the assessment reach by finding the Parameter Conditions for the left bank in the appropriate column and right bank in the appropriate row. Where the column and row intersect is the overall

[1] Maryland Department of Natural Resources. 1982. *The Buffer Study*.
[2] Chesapeake Bay Local Assistance Department. March 1991. *Information Bulletin Number 3*.

Parameter Condition for the **Riparian Buffer** Parameter. This is recorded in Section B of the Stream Assessment Field Form (Form 1).

Table 1: **Riparian Buffer** Conditions for the Inner and Outer 50 Feet of the **Riparian Buffer**

		Inner 50 Feet			
		Poor	**Marginal**	**Suboptimal**	**Optimal**
Outer 50 Feet	**Poor**	Poor	Marginal	Marginal	Suboptimal
	Marginal	Poor	Marginal	Suboptimal	Suboptimal
	Suboptimal	Poor	Marginal	Suboptimal	Optimal
	Optimal	Marginal	Suboptimal	Suboptimal	Optimal

Table 2: **Riparian Buffer** Conditions for the Left and Right Banks

		Left Bank			
		Poor	**Marginal**	**Suboptimal**	**Optimal**
Right Bank	**Poor**	Poor	Poor	Marginal	Marginal
	Marginal	Poor	Marginal	Marginal	Suboptimal
	Suboptimal	Marginal	Marginal	Suboptimal	Optimal
	Optimal	Marginal	Suboptimal	Optimal	Optimal

Riparian Buffer Parameter Conditions

The assessment reach is assessed for the condition of the **Riparian Buffer** using the following four Parameter Conditions. The Evaluator selects the Parameter Condition most representative of the assessment reach and applies them in Tables 1 and 2. The result is recorded in Section B of the Stream Assessment Field Form (Form 1).

Poor

Actively plowed cropland; mine lands; livestock feed lots; denuded surfaces; roads (paved or unpaved) or other impervious areas (roof tops); other comparable conditions

Note: Portions of the assessment reach that are within a bottomless culvert or bridge receive a Parameter Condition of *Poor* for the entire 100’ width.

Roadway and building are *Poor* buffers

Marginal
Lawns; mowed, or maintained areas; nurseries; standing crops or no-till cropland; active pasture; other comparable conditions

Suboptimal

Forest with sparse overstory canopy; forest with sparse scrub-shrub or herbaceous layers; scrub-shrub dominated cover; recent cutover or dense non-maintained herbaceous cover; inactive pasture or cropland; other comparable conditions

Optimal

Forest with multiple canopy layers present - well-developed herbaceous, scrub-shrub, and overstory canopies.

1.2.3 IN-STREAM HABITAT

The **In-Stream Habitat** assessment considers the suitability of the habitat for effective colonization or use by fish, amphibians, and/or macroinvertebrates. This parameter does not consider the abundance or types of organisms present, nor does it consider the water chemistry and/or water quality of the stream. Other factors beyond those measured in this methodology (i.e. watershed conditions) also affect the presence and diversity of aquatic organisms. Therefore, evaluation of this parameter seeks to assess the suitability of physical elements within the stream reach to support aquatic organisms.

For the purposes of evaluation, this parameter is divided into high gradient streams and low gradient streams, and the Evaluator is to use the appropriate section below. Generally speaking, low gradient streams occur in the Coastal Plain, wetland / marsh conditions, or wet meadows, and do not contain riffles. High gradient streams generally have alternating riffles and pools, with gravel present in the riffles. Typically, most streams west of the Fall Line are high gradient. Therefore, the majority of streams in Virginia would be considered high gradient, with the exceptions of streams in the Coastal Plain and low gradient streams flowing through wetlands or wet meadows throughout the state. This method does not establish a percent slope for distinguishing between high and low gradient streams.

The following descriptions are taken from EPA's *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish.*

> **High Gradient Streams** is defined by EPA as streams with moderate-high gradient landscapes; substrates primarily composed of coarse sediments [gravel (2mm) or larger] or frequent coarse particulate aggregations; riffle/run prevalent. (Go to No. 1 below)
>
> **Low Gradient Streams** is defined by EPA as streams with low-moderate gradient landscapes; substrates of fine sediment particles or infrequent aggregations of coarse sediment particles [gravel (2mm) or larger]; glide/pool prevalent. (Go to No. 2 below)

1. High Gradient Streams

Physical elements of high gradient stream systems that enhance a stream's ability to support aquatic organisms and are indicative of habitat diversity include the following:

- A varied mixture of substrate sizes (i.e., sand, gravel, cobbles, and boulders).
- Low amount of highly mobile substrate material – While most streambed substrate mobilizes under a particular discharge, substrate that remains immobile during the more consistent and frequent discharges provides stable habitat that fish and macroinvertebrates can utilize throughout differing stages of their lifecycles.
- Low Embeddedness of substrate material – Embeddedness is the extent to which rocks (gravel, cobble, and boulders) and snags are covered by silt, sand, or mud on the stream bottom. As rocks and snags become embedded, there is less area available for colonization for macroinvertebrates and less fish habitat. Generally, the less embedded each particle is, the more surface area available to macroinvertebrates and fish. Additionally, less embeddedness indicates less large-scale sediment movement and deposition. (Observations of embeddedness are taken in the upstream and central portions of riffles and cobble substrate areas.)
- A varied combination of water velocities and depths (riffles and pools) - More combinations of velocity and depth patterns provide increased habitat diversity.
- The presence of woody and leafy debris (fallen trees, logs, branches, leaf packs, etc.), root mats, large rocks, and undercut banks (below bankfull).
- The provision of shade protection by overhanging vegetation.

A diverse and abundant assemblage of these features promotes the potential for colonization by diverse and abundant epifaunal and fish communities.

High Gradient In-Stream Habitat Parameter Conditions

The assessment reach is assessed for the condition of in-stream habitat using the following three Parameter Conditions. The Evaluator selects the Parameter Condition most representative of the assessment reach. This is recorded in Section B of the Stream Assessment Field Form (Form 1).

Poor

Conditions are generally unsuitable for effective epifaunal colonization and/or fish cover. A stream is considered to provide *Poor* in-stream habitat if any of the following conditions exist within the assessment reach:

1. Substrate is homogeneous, highly mobile, or highly embedded (greater than 75%);
2. Little variability or combinations of water velocity and depth patterns;
3. Habitat elements listed above are lacking or are unstable. Habitat elements are typically present in less than 20% of the reach.

__Marginal__

Conditions are less than desirable, but generally suitable for at least partial colonization by a moderately diverse and abundant epifaunal community. Potential fish habitat is present, but is not abundant and does not occur evenly throughout the stream reach. *Marginal* in-stream habitat is present if the following conditions exist:

1. The substrate is comprised of a variety of substrate particle sizes, some of which are mobile and some of which are not highly mobile, and are moderately embedded (25 – 75%);
2. There is a combination of water velocity and depth patterns;
3. Habitat elements listed above are present, but are not plentiful or distributed evenly throughout the reach. Habitat elements are typically present in 20 – 70% of the reach and are adequate for maintenance of populations.

Optimal

Substrate is favorable for colonization by a diverse and abundant Epifaunal community, and there are many suitable areas for Epifaunal colonization and/or fish cover. *Optimal* habitat is present if the following conditions exist:

1. The substrate is comprised of a variety of substrate particle sizes that are neither highly mobile nor embedded (less than 25%);
2. There is a combination of water velocity and depth patterns;
3. The majority of habitat elements listed above occur frequently and are distributed evenly throughout the reach. Habitat elements are typically present in greater than 70% of the reach.

2. Low Gradient Streams

Physical elements of low gradient stream systems that enhance a stream's ability to support aquatic organisms and are indicative of habitat diversity include the following:

- A varied mixture of substrate materials (i.e., sand and gravel) in pools – Varied substrate materials support a higher diversity of organisms than mud or bedrock;
- Submerged aquatic vegetation in pools – Will also support a higher diversity of organisms;
- The presence of woody and leafy debris (fallen trees, logs, branches, leaf packs, etc.), root mats, and undercut banks (below bankfull)
- The provision of shade protection by overhanging vegetation.

A diverse and abundant assemblage of these features promotes the potential for colonization by diverse and abundant epifaunal and fish communities.

Low Gradient In-Stream Habitat Parameter Conditions

The assessment reach is assessed for the condition of in-stream habitat using the following three Parameter Conditions. The Evaluator selects the Parameter Condition most representative of the assessment reach. This is recorded in Section B of the Stream Assessment Field Form (Form 1).

Poor

Conditions are generally unsuitable for effective epifaunal colonization and/or fish cover. A stream is considered to provide *Poor* in-stream habitat if any of the following conditions exist within the stream:

1. Pool substrate composed primarily of hard-pan clay or bedrock;
2. No rootmat or submerged vegetation in pools;
3. Habitat elements listed above are lacking or are unstable. Habitat elements are typically present in less than 10% of the reach.

Marginal

Conditions are less than desirable, but generally suitable for at least partial colonization by a moderately diverse and abundant epifaunal community. Potential fish cover is present, but is not abundant and does not occur evenly throughout the stream reach. *Marginal* in-stream habitat is present if the following conditions exist:

1. Pool substrate composed of mud, sand, or clay;
2. Some rootmat or submerged vegetation may be present in pools;
3. Habitat elements listed above are present, but are not plentiful or distributed evenly throughout the reach. Habitat elements are typically present in 10 – 50% of the reach and are adequate for maintenance of populations.

Optimal

Substrate is favorable for colonization by a diverse and abundant Epifaunal community, and there are many suitable areas for epifaunal colonization and/or fish cover. *Optimal* habitat is present if the following conditions exist:

1. Pool substrate composed of a mixture of substrate materials, with gravel and firm sand prevalent;
2. Rootmat and submerged vegetation common;
3. The majority of habitat elements listed above occur frequently and are distributed evenly throughout the reach. Habitat elements are typically present in greater than 50% of the reach.

1.2.4 CHANNEL ALTERATION

Evaluation of this Parameter considers direct impacts to the stream channel from anthropogenic sources. The assessment reach may or may not have been altered throughout its entire length.

Examples of channel alterations evaluated in this Parameter that may disrupt the natural conditions of the stream include, but are not limited to the following:

- Stream crossings (bridges and bottomless culverts)
- Riprap along streambank or in streambed
- Concrete, gabions, or concrete blocks along streambank
- Straightening of channel
- Embankments on streambanks, including spoil piles
- Constrictions to stream channel or immediate flood prone area

It is important to note that this Parameter evaluates the physical alteration, separate from the impact that the alteration is having on the assessment reach. Any impact to the assessment reach resulting from the alteration (i.e. scouring, head cuts, vertical banks, etc.) is accounted for in the **Channel Condition** Parameter. Any revegetation or natural re-stabilization of the channel is also accounted for in the **Channel Condition** Parameter. For example, consider two assessment reaches, each with similar bridges: the first reach shows no adverse effects to the stream channel or banks; the second shows significant scouring. The alteration is the bridge, not the effects of the bridge; therefore it is the length of bridge relative to the length of the assessment reach that is evaluated. The shorter the assessment reach, the higher percentage of alteration. Similarly, this Parameter does not evaluate the effect of activities in the watershed, such as the adverse impacts from increased flow rates caused from upstream development. Such indirect effects are also accounted for in the **Channel Condition** Parameter. The four Parameter Conditions under **Channel Condition** are intended to describe geomorphic conditions associated with a stream's response to various factors, many of which are the result of channel alterations or activities in the watershed.

The presence of a structure does not necessarily result in a reduced score. For instance, a bridge that completely spans the floodplain would not be considered an alteration.

Channel Alteration Parameter Conditions

The assessment reach is assessed for the extent of channel alterations using the following four Parameter Conditions. The Evaluator selects the Parameter Condition most representative of the assessment reach. This is recorded in Section B of the Stream Assessment Field Form (Form 1).

Severe

Greater than 80% of reach is disrupted by any of the channel alterations listed in the parameter guidelines.

Note: Portions of the assessment reach that are within a bottomless culvert or bridge receive a Parameter Condition of *Severe*.

Moderate

40 - 80% of reach is disrupted by any of the channel alterations listed in the parameter guidelines.

Minor
Some of the reach is disrupted by any of the channel alterations listed in the parameter guidelines. Alterations may be in the form of stream crossings that do not disrupt the stream beyond the immediate area of impact.

Negligible

Disruptions by any of the channel alterations listed in the parameter guidelines are absent or minimal. Stream has an unaltered pattern, or a pattern that has "re-normalized." If a structure is present, it is non-impacting (i.e. bridge that spans floodplain).

Straightening of Channel, Channelization

Riprap on Banks

Straightening of Channel, Channelization, Constriction, Hardening of Banks

Bottomless Culvert

Note: minimization accomplished with cross-vane installation

Bridge Crossing with Instream Piers

1.3 Reach Condition Index (RCI)

The **Reach Condition Index (RCI)** places a numerical value to the stream assessment reach using the Parameter Conditions chosen during the assessment. It is a qualitative, relative measure of stream quality, as opposed to a quantitative, absolute measure of stream quality. The **RCI** values range from 0 to 7.0. These values were derived from the evaluation of the four Parameters – **Channel Condition, Riparian Buffer, In-stream Habitat,** and **Channel Alteration**. A relative weighting of each Parameter was then applied, such that the total sum of all four Parameters would equal 6.5 (note a weighting of 0.5 was given to the worst natural channels, equal to a man-made open channel lined with gabions or concrete blocks, to arrive at a maximum score of 7.0). The following table shows each Parameter's RCI weights.

Parameter	RCI Weight
Natural Channel	0.5
Channel Condition	2.5
Riparian	1.5
In-Stream Habitat	1.5
Channel Alteration	1.0
TOTAL	**7.0**

The next step was to determine the number of points to apply to each Parameter Condition within each Parameter. The amount of points applied to each Parameter Condition was determined based upon an inferred quality derived from the Parameter Condition's description, using zero points as the worst and the RCI Weight as the best. For example, **Channel Condition** has a total of five Parameter Conditions with a total RCI Weight of 2.5 points. Based upon the Parameter Condition descriptions and their inferred qualities, the points gained between *Severe* and *Poor* is less than the points gained between *Poor* and *Marginal* because the gain in quality is inferred to be less. The following table shows the number of points associated with each Parameter Condition:

Channel Condition	**Riparian Buffer**	**In-Stream Habitat**	**Channel Alteration**
Severe (0)	Poor (0)	Poor (0)	Severe (0)
Poor (0.5)	Marginal (0.5)		Moderate (0.3)
Marginal (1.3)		Marginal (0.8)	
Suboptimal (2.0)	Suboptimal (1.1)		Minor (0.7)
Optimal (2.5)	Optimal (1.5)	Optimal (1.5)	Negligible (1.0)

To summarize the **RCI** score, the **RCI** for a stream with a certain combination of Parameter Conditions is the summation of the points gained for each Parameter. For example, a natural channel (score = 0.5) with a *Marginal* **Channel Condition** (score = 1.3), *Suboptimal* **Riparian Buffer** (score = 1.1), *Marginal* **In-Stream Habitat** (score = 0.8), and *Minor* **Channel Alteration** (score = 0.7) has a **RCI** of 4.4.

The flowcharts located in Appendix B were developed using the table above and can be used to simply determine the **RCI** score.

1.4 Stream Quality Factor Determinations

This step converts the **RCI** score to a corresponding **Stream Quality Factor (SQF)** that is used in the **Compensation Requirement (CR)** equation (**Equation 1**) in Section 3.0 (Determining Stream Compensation Requirements). The purposes and benefits of this step are:

1. It groups streams with similar qualities so that slight variations in methodology interpretations, experience levels, and personal opinions are inconsequential to the final scoring.
2. It will limit debate over individual Parameter Conditions by grouping **RCIs** into **SQFs**.
3. It serves to discourage impacts to higher quality streams in order to decrease the **Compensation Requirement (CR)**.
4. It ensures that impacts to higher quality streams require more compensation than impacts to lower quality streams.

Table 3 depicts the **RCI** scores that convert to the corresponding **SQF**. This table depicts RCI scores obtained using the Natural Channel Assessment Methodology explained in this Manual (SICAM), as well as RCI scores obtained using the Corps of Engineers' (COE) Form 1 of the Stream Attribute Assessment Methodology (SAAM) dated October 13, 2005. The RCI score distributions for both the SICAM and the SAAM are approximately equal, however their application may not result in equal SQF's. This table will allow for more efficient comparisons of the two assessment methodologies during the testing and refinement period stated in the December 29, 2005 Joint Public Notice by DEQ and the COE.

Table 3: Stream Quality and Stream Quality Factors

SICAM RCI	SAAM RCI	Stream Quality	Stream Quality Factor (SQF)
0.5-0.7	0.00-0.28	*Severe*	1.0
0.8-1.7	0.29-1.12	*Poor*	1.1
1.8-3.7	1.13-3.00	*Marginal*	1.2
3.8-5.7	3.01-4.87	*Suboptimal*	1.3
5.8-6.7	4.88-5.71	*Optimal*	1.5
6.8-7.0	5.72-6.00	*Exceptional*	1.6

As depicted in Table 3, the higher the **RCI** score, the higher the **SQF**. Therefore, an assessment reach considered to have an *Exceptional* Stream Quality has the highest **SQF** of 1.6. Conversely, an assessment reach considered to have a *Severe* Stream Quality has the lowest **SQF** of 1.0.

The **SQF** obtained from Table 3 is then recorded in Section C of the Stream Assessment Field Form (Form 1), and is also used in the Compensation Requirement Worksheet (Form 2), included in Appendix A, to calculate the **Total Compensation Requirement (Total CR)** for the project.

2.0 IMPACT TYPE ASSESSMENT FOR STREAM IMPACT SITE

Permitted impacts result in varying levels of impairment to streams. Different types of impacts can therefore be classified based on the degree to which they are expected to impair the stream. Table 4 depicts a wide array of impacts categorized into Impact Classifications. Each Impact Classification has a corresponding **Impact Factor (IF)**. As depicted in Table 4, the more severe the impact, the higher the **IF**. Therefore, an activity considered to have a *Severe* impact has the highest **IF** of 1.0, representing an activity that is presumed to have a complete or near-complete loss of all beneficial stream functions. Conversely, an activity considered to have *Negligible* impacts has an **IF** of 0. These activities will not require stream compensation; however they are included in Table 4 to show that if impacts can be minimized to the point that the impact activity falls into the *Negligible* classification, then stream compensation is not required.

The corresponding **IF** obtained from Table 4 is used in the Compensation Requirement Worksheet (Form 2) included in Appendix A to calculate the **Total Compensation Requirement (Total CR)** for the project. The intent of using Impact Classifications and incorporating **IF's** into the equation for determining the **CR** is to ensure that impacts resulting in greater impairment require more compensation than impacts resulting in lesser impairment. Additionally, this serves as an incentive to decrease the degree of impact and ultimately the **CR**.

While Table 4 depicts a wide array of impacts and is intended to encompass the majority of impacts that require permits, it may not be all inclusive. In the event that an impact is not listed, best professional judgment must be used in determining the most applicable Impact Classification.

In the event that multiple impacts occur within the stream assessment reach (impact area), the highest applicable **IF** is applied to that reach. For example, if the reach will be widened and deepened (*Moderate* – 0.5) as well as having riprap lining placed in the streambed (*Significant* – 1), then the entire reach would be considered to have *Significant* impacts and have an **IF** of 1. Also, the total length of impact **(L_I)** equals the original length of stream being impacted, not the length of stream remaining after the impacts. For example, if 500' of stream is straightened resulting in 400' of stream, then 400' of stream is classified as *Moderate* (0.5) and 100' of stream is classified as *Severe* (1) due to elimination.

Table 4: Impact Classifications

Impact Classification	Impact Factor
Severe Elimination or filling of stream channel Impoundments (flooding of stream channel)[1] Hardening of stream bed (i.e., concrete, gabions, concrete blocks, riprap, countersunk & non-countersunk culverts[2,3])	1.0
Significant Hardening of stream banks (i.e., concrete, gabions, concrete blocks, riprap, bottomless culverts and other similar structures) Channel Alteration: (i.e., modifications to profile or habitat features; straightening or sinuosity modifications; modifications to cross-section or width/depth ratio through widening or narrowing bankfull channel, deepening bankfull channel, channel constriction)	0.75
Moderate Bridges with piers in the stream channel. Regulator's discretion is used to determine if piers result in the constriction of the stream channel and therefore warrant a *Moderate* ranking. Other activities not listed above that "alter the physical, chemical, or biological properties of surface waters" (9 VAC 25-210-50)	0.5
Negligible Bridge or other similar clear span structure (no permanent impacts to WOUS, including no riprap lining in stream channel, no piers in stream channel, no widening or constriction of stream channel)[4] Line one or both stream banks with concrete, riprap, or gabions, with <u>no</u> permanent impacts to WOUS	0

[1] Refer to GM01-2012 for measures to be taken for impoundments in surface waters. The length of impact is the total flooded length. Dams or other structures would be considered fill and those impacts are assessed separately.

[2] The addition of floodplain culverts to a plan will reduce the Impact Factor by 1 category, if the floodplain culverts are applicable, beneficial to the stream system, and properly sized for flood conveyance. An example of floodplain culverts is shown on the following page.

[3] The DEQ requirement to countersink culverts does not apply to extensions or maintenance of existing culverts that are not countersunk, to floodplain culverts being placed above ordinary high water, to culverts being placed on bedrock, or to culverts required to be placed on slopes 5% or greater.

[4] For projects with bridges with no permanent impact, floodplain culverts are encouraged and may be assessed as a minimization measure or mitigation for other impacts on the same stream in the vicinity of the bridge at the agency personnel's discretion.

Note: This table addresses permanent impacts to streams. Temporary impacts are those impacts which do not cause a permanent alteration of the physical, chemical, or biological properties of the stream. Temporary impacts include activities in which the ground is restored to its preconstruction contours and elevations, such that previous functions and values are restored. Temporary impacts are not accounted for through this methodology. If the stream cannot be restored back to original condition, the impact is considered to be permanent.

Floodplain culverts along the South Fork Holston River

Floodplain culverts along the South Fork Holston River

(VDOT)

3.0 Determining Stream Compensation Requirements

The amount of stream compensation required for a project is easily determined after the following three steps have been performed:

1) Complete the Stream Assessment Field Form(s) (Form 1) to obtain the **Reach Condition Index(ices) (RCI)** from the flowcharts in Appendix B and the corresponding **Stream Quality Factor(s) (SQF)** from Table 3;
2) Classify the type of impact and determine the appropriate **Impact Factor (IF)** from Table 4;
3) Determine the length of impact **(L_I)**.

The amount of stream compensation required is quantified and expressed in linear feet by using the following equation:

Compensation Requirement (CR) = L_I x SQF x IF   Equation 1

Where,

CR = length of stream compensation required (in linear feet)

L_I = length of impact (in linear feet)

SQF = Stream Quality Factor obtained from Table 3, or from Man-Made Channel Assessment (whichever applies)

IF = Impact Factor obtained from Table 4

To determine the **Compensation Requirement (CR)**, the length of impact **(L_I)** is multiplied by the appropriate **Stream Quality Factor (SQF)** from Table 3 and by the appropriate **Impact Factor (IF)** from Table 4. The resulting value is the **Compensation Requirement (CR)** for that single impact reach. The Compensation Requirement Worksheet (Form 2) is provided in Appendix A for the purpose of documenting all the information necessary to calculate the **CR** for each impact reach. The individual **L_I's** and the **CR's** are then summed on the Compensation Requirement Worksheet (Form 2) to calculate the total length of impact **(Total L_I)** and the **Total Compensation Requirement (Total CR)** for the project. The **Total CR** equals the total length of stream compensation required (in linear feet) for the project. The **Total CR** is then used in Section C of the Compensation Summary Worksheet (Form 4), included in Appendix C, to determine the **Weighted Debit**, after applying the Hydrologic Unit Code Factor as described in Section 4.4. The **Weighted Debit** is the linear footage required to be deducted from the compensation site or a stream bank. Fulfilling this requirement may be accomplished by various combinations of Compensation Categories. Sections 4.0 – 4.2 explain the Compensation Categories and the corresponding linear feet of credit obtainable from each of them. As described in the Introduction to this Manual, DEQ has provided an Excel file on it's website to aid in determining the **CR**, **Total CR**, and the linear footage of Compensation Categories required to fulfill the **Total CR.**

This method of computing stream compensation requirements takes into consideration the assessed condition of the existing stream to be impacted and the severity of the proposed impact. For example, a *Severe* impact to a low quality stream will not require as much compensation as a *Severe* impact to a high quality stream. A *Moderate* impact to a low quality stream will not require as much compensation as a *Severe* impact to a low quality stream. Due to these factors, this method, represented as **Equation 1**, offers avoidance and minimization incentives to applicants to decrease their compensation requirements. They can be decreased by avoiding impacts to higher quality streams, and/or by minimizing the severity of the impacts.

While this method may not eliminate the need for discussing compensation requirements, it does provide a high degree of consistency and predictability, and will foster more efficient decision-making for both the applicant and agency personnel. It enables both applicants and agency personnel to know the **Total CR** for the project early in the project development process. It also assists the applicant in proposing appropriate compensation plans by knowing what the linear footage compensation requirement will be and applying that to the amount of credit obtainable from the various methods explained in Section 4.1.

4.0 Fulfilling Compensation Requirements

The **Total Compensation Requirement (Total CR)** computed in Section 3.0 and on the Compensation Requirement Worksheet (Form 2) is the total length of stream compensation required (in linear feet) for the project. DEQ regulation (9 VAC 25-210-115) states that compensation proposals (i.e., methods of fulfilling compensation requirements) are evaluated in the following order of preference:

- onsite compensation
- offsite compensation
- purchase of Bank credits
- contribution to an approved in-lieu fee fund

This section describes the methods and alternatives for fulfilling the **Total CR** for both onsite and offsite compensation, and explains the crediting and debiting process associated with those methods. This process can also be used to determine the crediting and debiting process for stream banks evaluated and approved through the Mitigation Bank Review Team. In addition, it can be used to determine the appropriate credit given to projects undertaken by approved in-lieu fee fund entities. This process ensures that crediting on-site and off-site compensation projects, stream banks, and in-lieu fee fund projects are all credited in the same manner. This process does not include, however, a method for crediting out-of-kind compensation activities such as removing straight pipes, correcting acid mine drainage, or removing fish blockages. These activities may serve to fulfill the **Total CR** in certain situations, but will be assessed on a case-by-case basis.

The process described in this section categorizes compensation methods and utilizes a Credit Determination Worksheet (Form 3), included in Appendix C, to determine the linear footage of credit obtained from instituting various levels of preservation, enhancement, and restoration techniques. The linear footage of credit, known as **Compensation Credit (CC)** is then further refined by applying any of the various **Adjustment Factors (A_F)** to the credits obtained through the various techniques.

The following is a step-wise summary of the procedure for fulfulling compensation requirements:

STEP 1 **DETERMINE THE COMPENSATION CATEGORY** – refer to Section 4.1 for descriptions and photos of the Compensation Categories.

STEP 2 **DETERMINE COMPENSATION CREDIT (CC)** – refer to Section 4.2 and 4.2.1 to complete the Credit Determination Worksheet (Form 3) for each Compensation Category employed on a stream reach. Record the results in Section A of the Compensation Summary Worksheet (Form 4).

STEP 3 **DETERMINE ADJUSTED COMPENSATION CREDIT (ADJUSTED CC)** – evaluate whether any of the **Adjustment Factors (A_F)** presented in Section 4.3 apply to any of the stream reaches. Using the tables presented in Section 4.3, determine the appropriate **$A_{F's}$** and record the results on Forms 3 and 4. Totaling the data in Section A of the Compensation Summary Worksheet (Form 4) completes the credit determination process and results in the **Total Adjusted CC** for the project.

STEP 4 **APPLY HYDROLOGIC UNIT CODE FACTOR** – refer to Section 4.4 to determine if the compensation site location adheres to the Hydrologic Unit Code guideline, and apply the applicable factor to the **Total CR** in Section B of the Compensation Summary Worksheet (Form 4).

STEP 5 DETERMINE AMOUNT OF CREDITS TO DEBIT FROM THE COMPENSATION PROJECT – Complete Section B of the Compensation Summary Worksheet (Form 4) to determine the Weighted Debit required and to determine if there is a deficit or surplus of credit.

4.1 Compensation Categories

The **Total CR** can be fulfilled on a given project by utilizing a variety of methods in any combination. While recognizing that streams and watersheds vary in size, location, impairment levels, and restoration or enhancement needs, it is prudent to group many of the most common methods and techniques into categories for regulatory purposes of quantifying **Compensation Credit (CC)**. These methods and techniques are categorized into four Compensation Categories. These categories are described below and are in general ranked by the level of design, construction, and monitoring required for each Compensation Category. For example, *Restoration* activities receive more credit than the two levels of *Enhancement,* and *Preservation*. Additional details and examples of each Compensation Category are included in Section 4.2.1.

- ***Restoration –*** The process of converting an unstable, altered, or degraded stream corridor, including adjacent riparian zones (buffers) and flood-prone areas, to a natural stable condition considering recent and future watershed conditions. This process should be based on a reference condition/reach for the stream valley type and includes restoring the appropriate geomorphic dimension (cross-section), pattern (sinuosity), and profile (channel slope). This process supports reestablishing the biological and chemical integrity, including transport of the water and sediment produced by the stream's watershed in order to achieve dynamic equilibrium.

  Example photos: Both streams were relocated and reconnected to their floodplains using reference reach info to design proper dimensions, patterns, and profiles.

(The Nature Conservancy)

(Kimley-Horn and Associates, Inc.)

- ***Enhancement Level II –*** This Compensation Category generally includes the elements of Enhancement Level I and also incorporates activities that augment channel stability, water quality, and stream ecology in accordance with a reference condition where appropriate. These activities may include in-stream and/or streambank activities, but in total fall short of restoring one or more of the geomorphic variables: dimension, pattern and profile. Examples may include stabilization of streambanks using bioengineering techniques; reestablishing a connection to the floodplain; creation of bankfull benches; and introduction of in-stream habitat.

  Example photos:

Streambank stabilization using bioengineering techniques with coir logs along the toe.
(Wetland Studies and Solutions, Inc.)

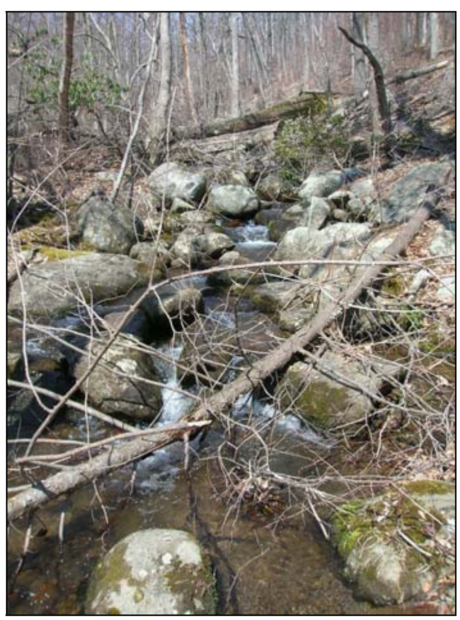
Bankfull benches were created and instream structure installed.
(N.C. State University)

- ***Enhancement Level I* -** This Compensation Category generally includes improvements to the stream banks and riparian zones. This Compensation Category provides somewhat less improved channel stability, water quality, and stream ecology. These activities are typically not designed in accordance with a reference condition, and oftentimes do not directly restore any of the geomorphic variables: dimension, pattern, and profile. Examples include riparian buffer establishment; non-point source removal activities (livestock exclusion, removing adjacent agriculture fields from further production, removing future timber harvest operations); bank revegetation; and removing or reducing impervious surfaces in the watershed.

  Example photo:

Riparian buffer planting.
(The Nature Conservancy)

- ***Preservation* -** Protection of ecologically important streams in perpetuity through the implementation of appropriate legal and physical mechanisms. Preservation includes the protection of riparian areas adjacent to streams as necessary to ensure protection or enhancement of the overall stream. The stream system should be a high quality, relatively undisturbed system that requires little or no enhancement activities.
  Example photos:



Stream was preserved with 200' buffers (on each side of the stream). The upstream watershed is also a protected parcel.
(The Nature Conservancy)

The applicant must apply the most appropriate methods and techniques to the stream based on best professional judgement and a thorough review of what level of restoration is needed. The inclusion of additional, unnecessary techniques for the purpose of obtaining additional credit is prohibited. The selection of the appropriate methods and techniques should be guided by an assessment of the existing stream deficiencies and the potential for the successful implementation of the methods and techniques. If *Preservation* or *Enhancement Level I* activities appear to be appropriate, then a simple assessment such as the Natural Channel Assessment Methodology presented in this Manual may be sufficient. However, streams with considerably more deficiencies that require *Enhancement Level II* or *Restoration* activities should use more quantitative stream assessment methods. This is because the restoration or enhancement of these streams require the correction of geomorphological and habitat parameters that are only accurately assessed through the survey and calculation of these parameters (i.e. entrenchment ratio, width-depth ratio, slope, sinuosity, etc.). Correcting these deficiencies typically requires reference conditions to be used as design guidelines. Therefore it is most helpful to compare the assessed conditions with reference conditions. Appendix D contains a list of typical data that may be considered for inclusion in this type of assessment. Additional data or other assessment methods are encouraged depending on site specific situations.

4.2 Compensation Category Crediting

Methods employed to improve or protect streams include a wide range of activities aimed at preserving, enhancing, stabilizing, or restoring various stream functions. Some of these methods require greater efforts and provide greater benefits than others. When these activities are proposed as compensation for stream impacts, the amount of effort required and the resulting benefits from such activities must be taken into account when determining the amount of **Compensation Credit (CC)** granted for these activities. Therefore, the amount of **Compensation Credit (CC)** (in linear feet) is based on the Compensation Category, the expected level of improvement to stream function and quality, and the amount of effort required and methods employed within each Compensation Category. The greatest amount of credit is given to extensive *Restoration* activities, while less credit is given for the varying degrees of stream *Enhancement* activities, and the least amount of credit is given for stream *Preservation*. This scaling of credits accounts for the decreased level of improvement to stream function and quality. Table 5 shows the Credit Ratios used to determine the **Compensation Credit (CC)** for each of the four Compensation Categories. Ranges are shown for the Enhancement and Preservation categories to allow some flexibility due to the multitude of possible enhancement activities and the different stream qualities being preserved.

Table 5: Compensation Category Credit Ratios

	Restoration	Enhancement Level II	Enhancement Level I	Preservation
Credit Ratio	1.0 : 1	1.5 – 2.25 : 1	3.0 – 3.75 : 1	5.0 - 20.0 : 1

4.2.1 Determining Credit Ratio

The following serves as a guideline for calculating the Credit Ratio for each of the four Compensation Categories. Applicants are encouraged to follow this guideline during development of the compensation plan to ensure they will fulfill the **Total Compensation Requirement (Total CR)** for the project.

This guideline was developed to provide credit for design components included in the compensation plan that can be analyzed for appropriateness based on stream type, valley type, reference conditions, and the stated objectives of the compensation plan. Therefore, it also provides examples of design components necessary for each Compensation Category so that both the applicant and agency personnel understand the requirements for achieving required amounts of **Compensation Credit (CC)**. It should be noted again that applying additional unnecessary methods or techniques on the compensation stream in order to obtain additional credit should be avoided, as this may cause adverse or unnecessary impacts to the stream channel. This guideline and the accompanying Credit Determination Worksheet (Form 3) are not to be used in this manner. For example, the placement of instream structures where none are warranted could actually cause unintended responses as the stream adjusts to the misplaced structure. As noted previously, the needed improvements should be based on an assessment of the existing stream deficiencies.

This guideline provides the regulatory process a high degree of consistency and predictability for determining **Compensation Credit (CC)** as it is tailored toward individual design components that are included in compensation plans. It may also help guide monitoring and the selection of success criteria. Success criteria are included in Appendix F, and their selection should be project specific. As stated in Appendix F, continued application of these succes criteria may reveal common correlations between certain restoration activities or Compensation Categories, and specific monitoring and success criteria applied to those activities or Categories.

The Credit Determination Worksheet (Form 3) is provided to: 1) document stream deficiencies in the compensation stream that were noted in the assessment and to document whether those deficiences are being addressed in the compensation plan; and 2) determine which activities are required in each Compensation Category and which result in additional credit. Space is allotted to note whether certain deficiencies or components warrant being restored, and if the compensation plan addresses or restores these deficiencies. In addition, each Compensation Category begins with the highest possible Credit Ratio and notes how much that ratio is reduced for each additional deficiency or component listed under that Category that is addressed in the compensation plan. Deficiencies or components listed under each Compensation Category that show a 0.0 Credit Ratio are generally required to be addressed in order for the activities to fall into that Compensation Category, or they are inherently addressed due to the definition and nature of that Compensation Category.

A single Credit Determination Worksheet (Form 3) is completed for each stream reach that employs a different compensation method or Compensation Category. Therefore, the evaluator must first determine which Compensation Category each stream reach falls into, then review the items listed under that Category in addition to the instructions in this Section. The evaluator should not need to review items listed under other Compensation Categories. Items in lower Categories should be addressed, however no additional credit is given for addressing them because the additional credit is obtained by being classified in the higher Compensation Category. For example, a *Restoration* project would not receive additional credit for instream structures or grade control (listed under *Enhancement Level II*) because they should already be included in the *Restoration* design. Also, a *Restoration* or *Enhancement Level II* project would not receive additional credit for buffer re-establishment (listed under *Enhancement Level I*) because a buffer is required in those Categories also. It is also important to note that addressing certain deficiencies or components in a higher Compensation Category does not guarantee that the project will be classified in that Category and receive the better credit. For example, an Enhancement Level II project may address the cross-sectional area of the stream (listed under *Restoration*) through physical manipulation of the streambank. However, that does not mean that the project will receive 1:1 credit. 1:1 credit is reserved for *Restoration* projects that typically address most, if not all, of the items listed under *Restoration* on Form 3.

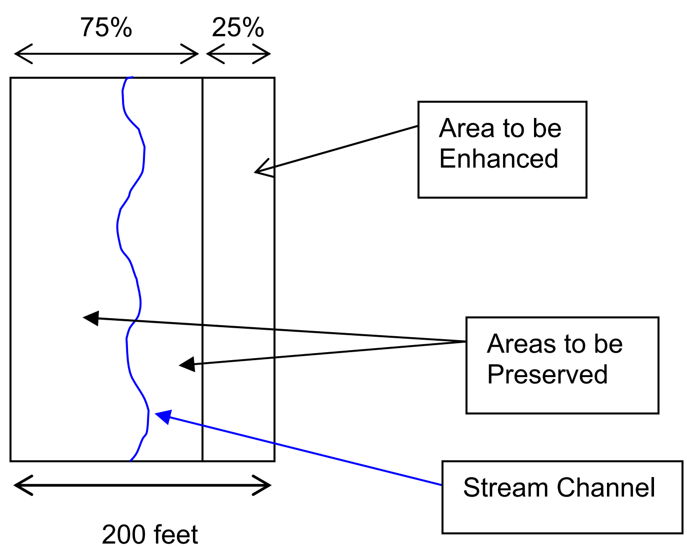
The compensation plan being analyzed must adequately address all the components in the Compensation Categories below that which the plan is placed in, if applicable. For example, a *Restoration* plan must adequately address all the components in *Enhancement Levels II & I*, and also in *Preservation*. The very nature and definitions of the different Categories practically ensure this by default. However, if an *Enhancement Level II* project does not contain impervious surfaces (listed under *Enhancement Level I*), then it is simply an item that does not need to be addressed. It does not mean that the project cannot be an *Enhancement Level II* project. To further explain, DEQ regulation (9 VAC 25-210-80) states that all compensation sites must be preserved in perpetuity, therefore, all *Restoration* and *Enhancement* projects must also be preserved in perpetuity. Additionally, *Restoration* or *Enhancement Level II* projects without a riparian buffer that excludes agricultural and silvicultural activites, and with extensive impervious surfaces would not be allowed. In other words, a riparian buffer that includes those activities or surfaces should not be included in the “preserved” width and counted as mitigation credit. The riparian buffer Adjustment Factor (Sectioin 4.3) may be applied if the preserved riparian buffer is less than 100’ but will result in reduced credit.

While analyzing the compensation plan, DEQ will take into account the adequacy of the method of addressing the listed components. For example, if one grade control structure is proposed on an *Enhancement Level II* project on a stream that currently has several headcuts migrating upstream, then the one structure will most likely not fix the problem. Therefore the credit ratio should not be reduced by 0.25, and the plan should be revised in order to deem it acceptable. A *Restoration* plan that randomly picks a proposed sinuosity will be scrutinized as well. The assessment of the existing stream, as well as the design data, should suppport the Credit Ratio conclusion.

The Credit Determination Worksheet (Form 3) is somewhat incremental in the manner in which it is used. As stated above, the evaluator chooses which Compensation Category the stream reach falls into. The evaluator then subtracts the indicated amount of Credit Ratio for the listed items in that Category from the starting Credit Ratio for that Category. Subtractions are not made for any items listed under any other Compensation Category. The final ratio is the number resulting from the starting Credit Ratio for that category minus the applicable subtractions. The appropriate **Adjustment Factors** (**A_F**) are then indicated and chosen but do not factor into the final ratio. They are used in the Compensation Summary Worksheet (Form 4).

Compensation plans that consist of various restoration activities require additional analysis to determine the proper credit ratio. A common example is when a portion of the buffer is enhanced and the remaining portions are preserved. In this case, the evaluator uses a percentage of the area to determine a weighted average credit ratio. For example:

> A stream with an *Optimal* rating will be preserved, however a portion of the buffer requires enhancement. One side of the stream will have a preserved 100' buffer. The other side will have the inner 50' preserved and the outer 50' will be enhanced. Therefore, 75% of the total 200' wide buffer receives a credit ratio of 5:1, and 25% of the total 200' wide buffer receives a credit ratio of 3.75:1. The weighted average credit ratio is then calculated as follows:
>
> Credit Ratio = (0.75 × 5) + (0.25 × 3.75) : 1
> Credit Ratio = (3.75 + .94) : 1
> Credit Ratio = 4.69:1



This same principle can be applied to other situations.

The results from each form are recorded on the Compensation Summary Worksheet (Form 4), included in Appendix C, which is used to summarize each individual stretch of stream and to calculate the **Adjusted Compensation Credits (Adjusted CC)** after **Adjustment Factors (A_F)**

are taken into consideration. The **Total Adjusted Compensation Credits (Total Adjusted CC)** is the total number of credits (in linear feet) that the compensation site provides.

The following provides additional guidelines to aid in determining the Credit Ratios using the Credit Determination Worksheet (Form 3).

- ***Restoration* = 1.0 : 1**
  As noted in the definition of *Restoration* in Section 4.1, these activities fully restore a stream corridor to natural stable conditions using the best available reference conditions as a design template. An analysis of the existing geomorphological parameters of the compensation stream is compared to those in a stable reference stream. Natural stream channel design methods and calculations are then applied to result in a stable stream dimension, pattern, and profile that maintains itself within the natural variability of the design parameters. Situations that readily lend themselves to inclusion in this *Compensation Category* include Priority 1, 2, or 3 relocations and restorations as described in *A Geomorphological Approach to Restoration of Incised Rivers*, Rosgen 1997[3].

  The following is a list of parameters required to be addressed for the activities to be considered *Restoration*. These are also listed on the Credit Determination Worksheet (Form 3). Restoration activities utilizing the natural stream channel design approach typically address all of these, therefore no additional credit is obtained by addressing any individual parameter.

  - Fix deficiencies in sinuosity, radius of curvature, belt width, meander length
  - Fix deficiencies in spacing, lengths, and depths for riffles, runs, pools, & glides
  - Restore appropriate critical shear stress
  - Fix deficiencies in slopes for channel, riffles, runs, pools, & glides
  - Fix deficiencies in width-depth ratio and cross-sectional area
  - Satisfy *Enhancement Level II*, *Enhancement Level I*, and *Preservation* requirements

  Note: Some sites may present difficulties in reestablishing an appropriate pattern (sinuosity) due to limitations in available belt width. Such difficulties often exist in the form of utilities, infrastructure, and other floodplain encroachments. (Further descriptions and examples are explained under Community Related Constraints in Section 4.3.) If the compensation site contains such constraints that prevent reestablishing appropriate sinuosity, the compensation plan may still be categorized as *Restoration* and receive a 1:1 credit ratio, assuming all other criteria are met. It is necessary to consider the available belt width and the proposed slope of the stream in the design of the particular stream type that is suitable for that situation. Information should be provided showing that the appropriate dimension, pattern, and profile are being restored for the proposed stream type in that particular situation. An example is the conversion of a G stream type to a B stream type, or an F stream type to a Bc stream type through Priority 3 restoration.

- ***Enhancement Level II* = 1.5 - 2.25 : 1**
  As noted in the definition of *Enhancement Level II* in Section 4.1, these activities improve channel stability and stream ecology, using the best available reference conditions as a design template where appropriate, but fall short of being a complete re-design of the pattern, dimension, and profile as required for *Restoration*. More often than not, the dimension and/or profile is restored or improved to naturally stable conditions utilizing a comparison of geomorphological parameters between the existing and the reference conditions, similar to that described under *Restoration*.

[3] Rosgen, David. 1997. *A Geomorphological Approach to Restoration of Incised Rivers*. Proceedings of the Conference on Management of Landscapes Disturbed by Channel Incision. 11pp.

This Compensation Category includes activities that directly improve the stability of, or enhance the streambanks, streambed, and in-stream habitat by physically manipulating them. By comparison, *Enhancement Level I* activities indirectly improve these through other actions not requiring the physical manipulation of existing contours.

The following is a list of parameters required to be addressed for the activities to be considered *Enhancement Level II*. These are also listed on the Credit Determination Worksheet (Form 3). Activities in this Compensation Category will always improve streambank stability, therefore no additional credit is obtained by addressing this parameter.

- Improve streambank stability using bioengineering and/or re-shaping
- Instream structures for bank stabilization & habitat improvement
- Instream structures for bank stabilization, habitat improvement, & grade control
- Improve bank height ***and*** entrenchment ratios
- Satisfy *Enhancement Level I*, and *Preservation* requirements

■ ***Enhancement Level I* = 3.0 - 3.75 : 1**

As noted in the definition of *Enhancement Level I* in Section 4.1, these activities improve stream quality and function by revegetating the streambanks and/or riparian zone, or making other ecological improvements to the stream's watershed. With the exception of preparing the soil for planting or removing impervious surfaces, this Compensation Category does not physically alter existing contours. Therefore, neither the stream's dimension, pattern, nor profile is directly improved.

The following is a list of parameters required to be addressed for the activities to be considered *Enhancement Level I*. These are also listed on the Credit Determination Worksheet (Form 3). Activities in this Compensation Category will not allow agriculture (crops or livestock) or silvicultural activities within the riparian zone, therefore these practices need to be prohibited for the compensation methods to fall into this Compensation Category. No additional credit is obtained by addressing the crops or silvicultural activities, however the removal of livestock receives an **Adjustment Factor** (**A_F**) as described in Section 4.3. Please note that if livestock exclusion is the only activity (with the exception of other required items listed below), then the project is credited in the Enhancement Level I category. Impervious surfaces are also not allowed within the riparian zone, however additional credit is obtainable for removing them due to the expense and potential improvement from this activity. Streambank vegetation sufficient to maintain long-term stability of the streambanks (e.g. trees and/or shrubs) is a necessary component of this Compensation Category. Whether it currently exists or needs to be planted, no additional credit is obtained for it. Similarly, no additional credit is obtained for enhancing the existing buffer, however it is a necessary component of this Compensation Category. Efforts to enhance the buffer to multiple stories must be taken. Additional credit is given if the buffer needs to be re-established as described below.

- Removal of agriculture or silviculture operations
- Additional plantings on streambanks
- Removal of impervious surfaces
- Buffer enhancement to multiple stories by planting native trees, shrubs, and grasses (existing vegetation remains undisturbed)
- Buffer re-establishment to multiple stories using native trees, shrubs, and grasses (existing vegetation requires preparation of new seedbed through removal of non-native/invasive species, and/or disking or tilling)
- Satisfy *Preservation* requirements

- ***Preservation* = 5.0 – 20.0 : 1**
  As noted in the definition of *Preservation* in Section 4.1, this activity places a stream and its riparian buffer under perpetual protection through the implementation of appropriate legal and physical mechanisms. No additional actions are typically taken as the stream should be stable with a high quality buffer. As a general rule this Compensation Category is to be used only for high quality streams that rate either *Exceptional*, *Optimal,* or *Suboptimal* as noted in Table 3. If a stream is not a high quality stream then *Enhancement* or *Restoration* is most likely warranted and may be encouraged. Accepting streams for *Preservation* that do not rate *Exceptional*, *Optimal,* or *Suboptimal* is at the agency personnel's discretion. There may be exceptions where a lower quality stream that rates either *Marginal, Poor,* or *Severe* as noted in Table 3 cannot or should not have *Enhancement* or *Restoration* activities performed on it. An example might be where there is a high quality riparian buffer that would need to be removed in order to complete the restoration and there is a strong threat for development. In this case, **Compensation Credit (CC)** is obtained merely for preserving the riparian buffer to remove that threat and help to prevent further degradation of the stream. It is not obtained because the stream itself qualifies for *Preservation*. In addition, sites that allow unlimited livestock access to a stream will not be accepted for preservation. The livestock should be excluded and the project should be credited in the Enhancement Level I category.

  The following is a list of the stream qualities shown on the Credit Determination Worksheet (Form 3). The stream quality is determined using the RCI conversions presented in Table 3. Justification must be given to preserve lower quality streams, and less credit is obtained for doing so.

  - *Severe* or *Poor* quality stream → 20.0 : 1
  - *Marginal* quality stream → 15.0 : 1
  - *Suboptimal* quality stream → 10.0 : 1
  - *Optimal* or *Exceptional* quality stream → 5.0 : 1

4.3 Adjustment Factors

Adjustment Factors (A_F) are used to account for exceptional or site specific circumstances associated with the compensation site. These circumstances may provide ecological benefits that exceed the minimal requirements of the method presented in this Manual, or they may provide less ecological benefits. The Adjustment Factors are applied only when ecological and/or water quality benefits are achieved. The agency representative shall make this determination on a case-by-case basis and use best professional judgment. The intent of incorporating an $\mathbf{A_F}$ into the overall compensation equation serves the following two purposes:

1. It enables applicants to propose compensation sites that might not otherwise be approved due to limitations, complications, or differing objectives, yet they are worthwhile projects that will provide ecological benefits. An example would be a site in which the riparian buffer is going to be maintained in herbaceous cover and managed for bobwhite quail instead of restoring to a multi-storied forest. The water quality benefits of such a buffer are diminished but not removed entirely, and may not warrant denial of the site. Therefore, an $\mathbf{A_F}$ that reduces the **Compensation Credit (CC)** is applied and the site can still be approved.
2. It enables applicants to obtain additional **Compensation Credit (CC)** for offering added or unique benefits with the site. An example would be a site in which critical habitat for a threatened or endangered species is preserved, enhanced, or restored. Such a site provides added ecological and cultural values over a similar site that does not.

The following paragraphs define and explain the five **Adjustment Factors (A_F)** that can be applied. In each case the $\mathbf{A_F}$ is recorded on each applicable Credit Determination Worksheet (Form 3), and is also recorded on the Compensation Summary Worksheet (Form 4). Further details on applying the multiple $\mathbf{A_F}$'s is provided in Section 5.0, Determining Adjusted Stream Compensation Credit.

1) Riparian Buffer

The standard riparian buffer for a stream compensation site is 100' wide on each side of the stream (total of 200' wide) with a multi-storied forested community. Exceptions may be granted when the standard width or community structure cannot be obtained due to various reasons. These exceptions may warrant a reduced **Compensation Credit (CC)**. Conversely, if the site provides buffer widths greater than the standard, increased **Compensation Credit (CC)** may be warranted. In the case where each side of the stream has a different buffer width, then the average of the two is used. An average width is also used if the buffer width is not a constant width throughout the length of the site. In the case where there are two streams that are less than 100' apart, the 100' buffer will overlap into the adjacent stream's 100' buffer. This will not result in a negative adjustment for each stream as long as the buffers on the opposite sides of each stream are at least 100'.

In the event that the entire watershed is preserved and results in average riparian buffer widths of less than 300 feet, an additional 0.1 is applied to the applicable $\mathbf{A_F}$. The Waterhsed Restriction $\mathbf{A_F}$ (below) is only applied when the watershed is being preserved and results in average riparian buffer widths of greater than 300 feet. When the Watershed Restriction $\mathbf{A_F}$ (below) is applied, the Riparian Buffer $\mathbf{A_F}$ is not. The adjustment of the Watershed Restriction $\mathbf{A_F}$ is higher than the riparian buffer because it provides additional protection.

Buffer Width on each side of stream (feet)	Factor
Less than 50 feet	-0.5
50 – 99	-0.2
100 – 149 or to watershed divide if less	0.0
150 - 199	0.1
200 - 300	0.2
>300 but less than the watershed divide	0.3
Any width that includes entire watershed	Add 0.1
Missing one vegetative community	Subtract 0.1
Missing two vegetative communities	Subtract 0.2

2) <u>Watershed Restrictions</u>

When preserving the compensation stream, the minimum area that must be preserved in perpetuity is the reaches of stream being restored, enhanced, or preserved plus the designated riparian buffer. If the compensation site incorporates additional legal mechanisms that prohibit any increase in runoff rates in the watershed above existing rates, and the site is designed to accommodate the existing rates, then increased **Compensation Credit (CC)** may be warranted. These legal mechanisms may be in the form of preserving the entire watershed as is, or instituting future runoff restrictions within the watershed. This factor does not apply to sites designed to accommodate future increases in runoff rates that do not incorporate these additional legal mechanisms. This factor also does not apply if such restrictions are already in place. When the Watershed Restriction $\mathbf{A_F}$ is applied, the Riparian Buffer $\mathbf{A_F}$ is not. The adjustment of this factor is higher than the riparian buffer because it provides additional protection. When the entire watershed on small headwater streams is less than or equal to 300' wide and the Watershed Restriction $\mathbf{A_F}$ is applicable, the Riparian Buffer $\mathbf{A_F}$ is applied instead.

Watershed Restrictions	Factor
Legal mechanisms not instituted	0.0
Legal mechanisms instituted	0.4

3) <u>Rare, Threatened, and Endangered Species or Communities</u>

Compensation sites should be located where there is an obvious need for restoration, enhancement, or preservation. Communities of rare, threatened, or endangered fauna and flora may be found in such areas. State and Federal agencies, and society as a whole, have placed certain cultural or societal values on such species or communities. It is therefore appropriate to warrant increased **Compensation Credit (CC)** for sites that show a significant improvement in restoring, enhancing, or preserving these species or communities. It is necessary to consider the influences of activities upstream of the compensation site before applying this $\mathbf{A_F}$. If upstream activities would prevent significant improvement from occurring, this $\mathbf{A_F}$ may not be warranted. The agency representative should coordinate with State and Federal agencies such as DCR, DGIF, or FWS prior to applying this $\mathbf{A_F}$.

Rare or T & E Species or Community	Factor
No significant improvement	0.0
Significant improvement	0.2

4) **<u>Community Related Constraints</u>**

Community infrastructure that is typically present in developed or developing areas can have a profound impact on streams. These streams have often been severely impacted, and present unique restoration and enhancement challenges. The challenges are often present in the form of utilities located adjacent to or in the streambed; community infrastructure encroaching on the stream's floodplain preventing a natural distribution of flood flows and energy, and proper pattern, dimension, and profile; high runoff rates; high degrees of incision caused by a combination of these factors; and multiple property owners with multiple objectives. These challenges present constraints on stream restoration and enhancement activities that are less likely to be present in areas containing more open space. These constraints increase the cost of performing restoration and enhancement activities over those performed in other areas that generally do not contain these challenges and constraints. Therefore, stream compensation in such areas is not an economical alternative unless the amount of credit obtainable per cost is generally equivalent to that of areas without such challenges and constraints. It is therefore appropriate to warrant increased **Compensation Credit (CC)** for the successful completion of restoration or enhancement of these sites.

The decision by agency personnel to grant this $\mathbf{A_F}$ is based on the presence or absence of such challenges and constraints, rather than if the site is located in a developed or developing watershed or not. Therefore, sites eligible for this $\mathbf{A_F}$ could include streams in rural environs that pose such challenges and constraints in a localized area. On the contrary, sites located in a developed or developing watershed are not guaranteed to receive this $\mathbf{A_F}$ if the site does not pose such challenges and constraints. This $\mathbf{A_F}$ is only applied to stream reaches that warrant it. It does not have to apply to the entire site. If such constraints are only present in a certain reach of the entire site then only that reach receives this $\mathbf{A_F}$. In addition, this $\mathbf{A_F}$ does not apply to *Preservation* or *Enhancement Level I* activities, as these activities do not involve intensive redesign or construction of stream channels and their floodplains. This $\mathbf{A_F}$ should be applied sparingly and only if alternatives to overcome the constraints are not available. For example, if a sewer line is located along a stream, and even crosses it, but there is a wide riparian buffer where the stream can be relocated, this $\mathbf{A_F}$ may not apply. Likewise this $\mathbf{A_F}$ does not apply if steep banks or an incised channel are the only limitations.

Presence of Community Related Constraints	Factor
Few challenges and constraints	0.0
Many challenges and constraints	0.5

5) **<u>Livestock Exclusion</u>**

Livestock exclusion is a process of placing fencing around a stream and adjacent riparian buffer so that livestock access is limited. It is widely recognized that a site that allows unlimited livestock access to a stream has significant water quality and streambank stability problems over many sites that do not. It is therefore appropriate to warrant increased **Compensation Credit (CC)** for all sites that exclude livestock. It should be noted that in order for a site to be accepted as compensation, livestock must be excluded from the stream and adjacent riparian buffer. In other words, a site in which the applicant proposes not to exclude livestock will not be accepted as a compensation site. However, infrequent livestock crossings or watering holes may be permitted, if necessary.

Livestock Exclusion	Factor
Livestock not excluded	0.0
Livestock excluded	0.3

4.4 Hydrologic Unit Code Factor

When compensation is proposed at an off-site location or a bank, the site or bank should be located within the same 8 digit Hydrologic Unit Code (HUC) or an adjacent HUC in the same river basin and physiographic province (e.g. coastal plain, piedmont). This guideline is intended to compensate for lost functions and values within the same or adjacent HUC in the same river basin and physiographic province.

If this guideline is not adhered to, the **Total Compensation Requirement (Total CR)** will be increased by a multiplication factor of 1.5. This adjustment occurs in Section B of the Compensation Summary Worksheet (Form 4).

If this guideline is adhered to, a multiplication factor of 1.0 is applied, resulting in no adjustment.

5.0 Determining Adjusted Stream Compensation Credit

The final amount of stream compensation credit obtained on a compensation site is easily determined after the following steps have been performed:

1) The Credit Determination Worksheet (Form 3) is completed to determine the appropriate Credit Ratios for the selected reaches and methods. The results are recorded on the Compensation Summary Worksheet (Form 4).
2) The applicable **Adjustment Factors (A_F)** are recorded on the Credit Determination Worksheet (Form 3) and the Compensation Summary Worksheet (Form 4).
3) The lengths of each compensation reach **(L_C)** are recorded on the Compensation Summary Worksheet (Form 4).

The **Adjusted Compensation Credit (Adjusted CC)** is quantified and expressed in linear feet by using the following equation:

Adjusted CC = (L_C ÷ Credit Ratio) x (1.0 + A_F + A_F + A_F + A_F + A_F) (Equation 2)

Where,

Adjusted CC = total amount of credit obtained (in linear feet)

L_C = stream length of compensation reach (in linear feet)

Credit Ratio = the final ratio obtained from the Credit Determination Worksheet (Form 3)

A_F = the Adjustment Factor obtained from each of the five available Adjustment Factors described in Section 4.3.

To determine the **Adjusted Compensation Credit (Adjusted CC)**, the length of the compensation reach **(L_C)** is divided by the appropriate **Credit Ratio** from the Credit Determination Worksheet (Form 3). This quotient is then multiplied by the sum of **1.0** plus each of the individual **Adjustment Factor's (A_F)** from Section 4.3. The resulting value is the **Adjusted Compensation Credit (Adjusted CC)** for that single compensation reach.

<u>Example</u>: A 100' stream reach (**L_C** = 100') receives a Credit Ratio of 2.0:1, and receives the following **Adjustment Factor's (A_F)**:
Riparian Buffer = -0.2
Watershed Restrictions = 0.0
Rare or T & E species = 0.0
Community Related Constraints = 0.0
Livestock Exclusion = 0.3

The equation is as follows:
Adjusted CC = (100' ÷ 2.0) × (**1.0** – 0.2 + 0.0 + 0.0 + 0.0 + 0.3)
Adjusted CC = (50') × (1.1)
Adjusted CC = 55' (Note: Round all final numbers to the nearest whole number)

The Compensation Summary Worksheet (Form 4) is provided for documenting all the information necessary to calculate the **Adjusted CC** for each compensation reach. Both the **L_C** and the **Adjusted CC** are then totalled on the same Compensation Summary Worksheet (Form 4) to calculate the total length of compensation **(Total L_C)** and the **Total Adjusted Compensation Credit (Total Adjusted CC)** for the site. The **Total Adjusted Compensation Credit (Total Adjusted CC)** equals the total number of credits (in linear feet) that the compensation site provides.

In Section B the **Total Compensation Requirement (Total CR)** (obtained from the Compensation Requirement Worksheet Form 2) is multiplied by the **HUC Factor** to obtain the **Weighted Debit**. The **Weighted Debit** is used to determine if the compensation site fulfills the **Total CR**, or to determine the amount to be debited from a Bank.

This method of computing stream compensation credits recognizes variations in impairment levels and requirements for repair by offering four different Compensation Categories. Within most categories, varying amounts of credit can be obtained depending on the level of work completed, which is guided by an assessment of existing stream deficiencies. It also allows **Adjustment Factors (A_F)** to be applied without altering the Credit Ratios, regardless of the combination of Categories used at the site. By consistently applying the Credit Ratios and **A_F's** to compensation plans, applicants can accurately predict the amount of credit they will obtain, thereby knowing the linear footage of stream required for compensation. Standardizing the crediting of sites in this manner ensures that all sites (on-site, off-site, stream banks, and in-lieu fee fund sites) are credited equitably regardless of what combination of Compensation Categories comprise the site. While this method may not eliminate the need for discussing compensation credits during the permit review process, it does provide a high degree of consistency and predictability, and will foster more efficient decision-making for both the applicant and agency personnel.

5.1 Determining Length of Compensation (L_C)

Section 5.0 enables the agency representative and the applicant to calculate the amount of credit (in linear feet) obtained from a compensation site. It may also be necessary for an applicant to determine how many linear feet of compensation will be required at a particular site to compensate for the **Total Compensation Requirement (Total CR)** obtained from Section 3.0 and Form 2. The **Total CR** is equivalent to the **Total Adjusted Compensation Credit (Total Adjusted CC)** that needs to be obtained from a compensation site. Therefore, the length of compensation **(L_C)** required to fulfill the **Total CR** at a particular site can be determined by solving for $\mathbf{L_C}$ in the following equation, which is almost identical to **Equation 2** in Section 5.0:

$$\textbf{Total CR} = (\mathbf{L_C} \div \textbf{Credit Ratio}) \times (1.0 + A_F + A_F + A_F + A_F + A_F) \quad \textbf{(Equation 3)}$$

Upon assessing the existing condition of the compensation site, a stream restoration practitioner can estimate the Credit Ratio that would be obtained at the site based on the type of restoration activities that are necessary and using the Credit Determination Worksheet (Form 3). The applicable **Adjustment Factors (A_F)** can also be determined at this stage. The applicant then inputs the appropriate numbers into **Equation 3** and solves for $\mathbf{L_C}$.

<u>Example</u>: A project has a **Total CR** of 100'. The applicant finds a compensation stream that has been channelized in the past, is severely degraded, and flows through an active cattle pasture. The stream requires *Restoration* with a Credit Ratio of 1:1, the cattle will be excluded, and 200' buffers will be established on each side of the stream. The **Adjustment Factors (A_F)** are as follows:

Riparian Buffer = 0.2
Watershed Restrictions = 0.0
Rare or T & E species = 0.0
Community Related Constraints = 0.0
Livestock Exclusion = 0.3

The equation is as follows:
100' = ($\mathbf{L_C}$ ÷ 1.0) × (**1.0** + 0.2 + 0.0 + 0.0 + 0.0 + 0.3)
100' = ($\mathbf{L_C}$ ÷ 1.0) × (1.5)
66.66' = ($\mathbf{L_C}$ ÷ 1.0)
67' = $\mathbf{L_C}$ (Note: Round all final numbers to the nearest whole number)

Equation 3 can also be changed to the following:

$$\mathbf{L_C} = [\textbf{Total CR} \div (1.0 + A_F + A_F + A_F + A_F + A_F)] \times \textbf{Credit Ratio}$$

If the compensation site is not located within the same 8 digit HUC as the impact site or in an adjacent HUC in the same river basin and physiographic province, then $\mathbf{L_C}$ needs to be multiplied by the HUC Factor of 1.5 to obtain the proper length required.

Appendix A

Stream Impact Site Assessment Forms

Stream Assessment Field Form (Form 1)

Project Name and JPA Number:	
Stream ID:	Date:
Reach ID:	HUC:
Reach Length:	Locality:
Evaluators:	

A **Man-Made Channels**. (Circle the assigned SQF)

1. Culvert (except bottomless) → 0
2. Open Channel - concrete → 0.25
3. Open Channel – gabions or blocks → 0.5
4. Open Channel – riprap → **Apply Natural Channel Assessment Methodology**
5. No hardened bottom →
6. Naturalized →

B **Natural Channel Methodology**
Evaluate the following parameters using the definitions provided in Sections 1.2.1 - 1.2.4.

1. Channel Condition

- O *Severe*
- O *Poor*
- O *Marginal*
- O *Suboptimal*
- O *Optimal*

2. Riparian Buffer

L Inner	*L Outer*	*L Bank*	*R Inner*	*R Outer*	*R Bank*	***Overall***
o	o	O	o	o	O	O *Poor*
o	o	O	o	o	O	O *Marginal*
o	o	O	o	o	O	O *Suboptimal*
o	o	O	o	o	O	O *Optimal*

3. In-Stream Habitat

- o ***High Gradient***
- o ***Low Gradient***

- O *Poor*
- O *Marginal*
- O *Optimal*

4. Channel Alteration

- O *Severe*
- O *Moderate*
- O *Minor*
- O *Negligible*

C **Calculations** After evaluating the parameters, use the RCI Flow Charts to determine the RCI, & Table 3 to determine the Stream Quality & SQF.

Reach Condition Index (RCI) (0 - 7) = ________
Stream Quality = __________
Stream Quality Factor (SQF) = ________

D Attach properly labeled, representative photos of the assessment reach.

Notes:

Summarize the information for all assessment reaches on FORM 2

Compensation Requirement Worksheet (Form 2)

Project Name and JPA Number:	
Stream ID:	Date:
Evaluators:	HUC:

Reach ID	**Length of Impact (L_I)** (feet)	**Stream Quality Factor (SQF)**	**Impact Factor (IF)**	**Compensation Requirement (CR)** (feet) **(L_I × SQF × IF)**
Total L_I			**Total CR**	

Note: Round all **CR**'s to the nearest whole number.

Appendix C

Compensation Crediting Worksheets

Credit Determination Worksheet (Form 3)

Project Name and JPA Number:	
Stream ID:	Date:
Reach ID:	HUC:
Reach Length:	Locality:

Compensation Category	Warranted / Required	Addressed in Compensation Plan	Credit Ratio (+/-)	Ratio Results (X:1)
Restoration (1:1)	*Priority 1, 2, or 3 Relocation / Restoration*		**1.0**	
Sinuosity			0.0	
Radius of Curvature			0.0	
Belt Width			0.0	
Meander Length			0.0	
Riffle/Pool Spacing, Lengths, Depths			0.0	
Critical Shear Stress			0.0	
Riparian Buffer			0.0	
Slope (channel and/or features)			0.0	
Width / Depth Ratio			0.0	
Cross-Sectional Area			0.0	
Enhancement Level II (1.5-2.25:1)	*Streambank and Instream Enhancement*		**2.25**	
Streambank Stability			0.0	
Instream Structures and/or Habitat			-0.25	
Grade Control			-0.25	
Bank Height & Entrenchment Ratios			-0.25	
Enhancement Level I (3.0-3.75:1)	*Riparian and Streambank Enhancement*		**3.75**	
Ag./Silv. in Riparian Zone			0.0	
Streambank Plantings			0.0	
Remove Impervious Surfaces			-0.25	
Buffer Enhancement (multiple stories)			0.0	
Buffer Re-establishment (multiple stories)			-0.50	
Preservation (5-20:1)	*No physical improvements; pristine riparian buffer*			
Severe or Poor Quality			**20.0**	
Marginal Quality			**15.0**	
Suboptimal Quality			**10.0**	
Optimal or Exceptional Quality			**5.0**	
			Final Ratio	

Adjustment Factors

Buffer Width	-0.5, -0.2, 0.0, 0.1, 0.2, 0.3	
Watershed Restrictions	0.0, 0.4	
Rare, Threatened, & Endangered Species or Communities	0.0, 0.2	
Community Related Constraints (Restoration & Enhancement II only)	0.0, 0.5	
Livestock Exclusion	0.0, 0.3	

Compensation Summary Worksheet (Form 4)

Project Name and JPA Number:	
Stream ID:	Date:
Locality:	HUC:

Section A:

Reach ID	**Comp. Length (L_c)** (feet)	**Credit Ratio**	**Buffer A_F**	**Watershed A_F**	**T&E A_F**	**Constraints A_F**	**Livestock A_F**	**Adjusted Compensation Credit (Adjusted CC)** (feet) **(L_C ÷ Credit Ratio) × (1.0+A_F +A_F+ A_F+A_F+ A_F)**
Total L_C							**Total Adjusted CC**	

Note: Round all **Adjusted CC**'s to the nearest whole number.

Section B:

Total Compensation Requirement (Total CR) = ____________ (From Form 2)

HUC Factor = _________ (From Section 4.4)

Weighted Debit = Total CR × HUC Factor = ___________

Total Adjusted Compensation Credit (Total Adjusted CC) = _________ (From Form 4, Section A)

- If TOTAL Adjusted CC is ≥ Weighted Debit, compensation is satisfied.
- If TOTAL Adjusted CC is < Weighted Debit, additional compensation is required.

Additional Compensation (linear feet) required _______________

Surplus Compensation (linear feet) provided _________________

Appendix D

Geomorphological Parameters for Advanced Assessment of Stream Condition and Design Development

Variables	Existing Stream	
	Mean	Range
1. Stream type (Rosgen)		
2. Drainage area (sq. mile)		
3. Bankfull width, W_{bkf} (ft)		
4. Bankfull mean depth, d_{bkf} (ft)		
5. Bankfull cross-sectional area, A_{bkf} (ft^2)		
6. Width/depth ratio (W_{bkf} / d_{bkf})		
7. Bankfull max depth, d_{max} (ft)		
8. Max depth ratio, d_{max} / d_{bkf}		
9. Width of flood-prone area, W_{fpa} (ft)		
10. Entrenchment ratio (W_{fpa} / W_{bkf})		
11. Top of lowest bank, TOLB (ft)		
12. Bank height ratio (BHR), TOLB / d_{max}		
13. Bankfull velocity, V_{bkf} (fps)		
14. Bankfull discharge, Q_{bkf} (cfs)		
15. Meander length, L_m (ft)		
16. Meander length ratio, L_m / W_{bkf}		
17. Radius of curvature, R_c (ft)		
18. Radius of curvature ratio, R_c / W_{bkf}		
19. Belt width, W_{blt} (ft)		
20. Meander width ratio (MWR), W_{blt} / W_{bkf}		
21. Sinuosity (K), stream length / valley length		
22. Valley slope, VS (ft/ft)		
23. Channel slope (S_{ave}), VS / K (ft/ft)		
24. Water surface slope, S (ft/ft)		
25. Riffle slope, S_{rif} (ft/ft)		
26. Riffle slope ratio, S_{rif} / S		
27. Run slope, S_{run} (ft/ft)		
28. Run slope ratio, S_{run} / S		
29. Pool slope, S_{pool} (ft/ft)		
30. Pool slope ratio, S_{pool} / S		
31. Glide slope, S_{glide} (ft/ft)		
32. Glide slope ratio, S_{glide} / S		
33. Riffle length, L_{rif} (ft)		
34. Riffle length ratio, L_{rif} / W_{bkf}		
35. Pool length, L_{pool} (ft)		
36. Pool length ratio, L_{pool} / W_{bkf}		
37. Run depth, d_{run} (ft)		
38. Run depth ratio, d_{run} / d_{bkf}		
39. Pool max depth, d_{pool} (ft)		
40. Pool depth ratio, d_{pool} / d_{bkf}		
41. Glide depth, d_{glide}		
42. Glide depth ratio, d_{glide} / d_{bkf}		
43. Pool width, W_{pool} (ft)		
44. Pool width ratio, W_{pool} / W_{bkf}		
45. Pool area, A_{pool} (ft^2)		
46. Pool area ratio, A_{pool} / A_{bkf}		
47. Pool to pool spacing, p-p		
48. Pool to pool spacing ratio, p-p / W_{bkf}		
Particle Size distribution of channel material		
D 16		
D 35		
D 50		

D 84		
D 95		
Particle Size distribution of bar material		
D 16		
D 35		
D 50		
D 84		
D 95		

Appendix E

Field Manual

Stream Assessment Field Form (Form 1)

Project Name and JPA Number:	
Stream ID:	Date:
Reach ID:	HUC:
Reach Length:	Locality:
Evaluators:	

A **Man-Made Channels**. (Use the assigned SQF)

1. Culvert (except bottomless) → 0
2. Open Channel - concrete → 0.25
3. Open Channel – gabions or blocks → 0.5
4. Open Channel – riprap →
5. No hardened bottom →
6. Naturalized →

Apply Natural Channel Assessment Methodology

B **Natural Channel Methodology**

Evaluate the following parameters using the definitions provided in Sections 1.2.1 - 1.2.4.

1. Channel Condition

- O *Severe*
- O *Poor*
- O *Marginal*
- O *Suboptimal*
- O *Optimal*

2. Riparian Buffer

L Inner	*L Outer*	*L Bank*	*R Inner*	*R Outer*	*R Bank*	***Overall***
o	o	O	o	o	O	O *Poor*
o	o	O	o	o	O	O *Marginal*
o	o	O	o	o	O	O *Suboptimal*
o	o	O	o	o	O	O *Optimal*

3. Instream Habitat

- o ***High Gradient***
- o ***Low Gradient***

- O *Poor*
- O *Marginal*
- O *Optimal*

4. Channel Alteration

- O *Severe*
- O *Moderate*
- O *Minor*
- O *Negligible/None*

C **Calculations** After evaluating the parameters, use the RCI Flow Charts to determine the RCI, & Table 3 to determine the Stream Quality & SQF.

Reach Condition Index (RCI) (0 - 7) = ________
Stream Quality = __________
Stream Quality Factor (SQF) = ________

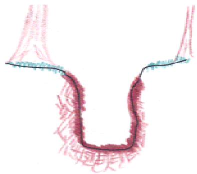
D Attach properly labeled, representative photos of the assessment reach.

Notes:

Summarize the information for all assessment reaches on FORM 2

CHANNEL CONDITION

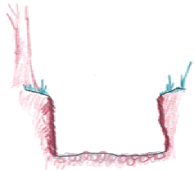
SEVERE



Channels are deeply incised with vertical and/or lateral instability. Flow is contained within the banks during heavy rainfall events (i.e. the stream does not have access to its floodplain). Bankfull may be difficult to determine. Vegetative surface protection along both banks is non-existent or minimal (less than 20%), and is insufficient to prevent significant erosion from continuing. If present, sediment deposition is infrequent, temporary, and highly transient in nature **-OR-** These channels are aggrading and have an excessive sediment supply that has filled the channel with alluvium, impeding its flow. Multiple thread channels and/or subterranean flow may be present.

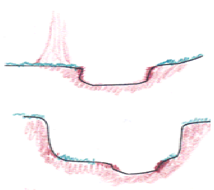
Note: Portions of the assessment reach that are within a bottomless culvert or bridge receive a Parameter Condition of *Severe*.

POOR



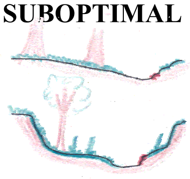
Channels are not as deeply incised as the *Severe* Channel Condition. Channels are also vertically and/or laterally unstable, however they are more likely to widen more so than incise further. The majority of both banks are vertical with shallow to moderate root depths. Bankfull may be difficult to determine. Vegetative surface protection along both banks is minimal to moderate (20% to 40%), and is insufficient to prevent significant erosion from continuing. If present, sediment deposition is temporary and transient in nature, and/or contributes to channel instability.

MARGINAL



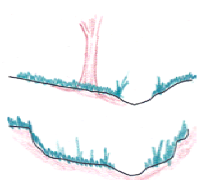
Channels are most often incised, but to a lesser degree than the *Severe* and *Poor* Channel Conditions. Channel shows signs of active erosion or unprotected banks and comparable amounts of stable banks due to flatter slopes and/or vegetative surface protection. The streambanks may consist of some vertical or undercut banks. While portions of the bankfull channel may still widen, other portions have begun to narrow in an attempt to obtain proper dimensions. The channel is attempting to define bankfull and low flow channels (when appropriate for the stream type). Vegetative surface protection is present on one or both banks, but is not continuous. Some vegetative surfaces may be the result of recent bank slumping. Depositional features (point bars, mid-channel bars, transverse bars, and bankfull benches) are likely beginning to form (when appropriate for the stream type) and some appear to be contributing toward channel stability.

SUBOPTIMAL



These channels are slightly incised and contain few areas of active erosion or unprotected banks,_but the majority of both banks are stable with vegetative surface protection or natural rock stability present along the majority of both banks. The bankfull and low flow channels (when appropriate for the stream type) are well defined. Depositional features (point bars, mid-channel bars, transverse bars, and bankfull benches) are likely present (when appropriate for the stream type) and most are contributing to stability. This stream likely has access to bankfull benches, or newly developed floodplains along portions of the reach.

OPTIMAL



These channels show very little incision and little or no evidence of active erosion or unprotected banks. Vegetative surface protection is prominent along both banks. Stable point bars and bankfull benches are present (when appropriate for the stream type), however mid-channel bars, and transverse bars should be few. The bankfull and low flow channels (when appropriate for the stream type) are well defined. These channels are stable and have access to their original floodplain or fully developed wide bankfull benches.

RIPARIAN BUFFER

POOR - Actively plowed cropland; mine lands; livestock feed lot; denuded surfaces; roads (paved or unpaved) or other impervious areas; other comparable conditions

Note: Portions of the assessment reach that are within a bottomless culvert or bridge receive a Parameter Condition of *Poor* for the entire 100’ width.

MARGINAL - Lawns, mowed, or maintained areas; nurseries; standing crops or no-till cropland; active pasture; other comparable conditions

SUBOPTIMAL - Forest with sparse overstory canopy; forest with sparse scrub-shrub or herbaceous layers; scrub-shrub dominated cover; recent cutover or dense non-maintained herbaceous cover; inactive pasture or cropland; other comparable conditions

OPTIMAL - Forest with multiple canopy layers present - well-developed herbaceous, scrub-shrub, and overstory.

Table 1: Riparian Buffer Conditions for the Inner and Outer 50 Feet of the Riparian Buffer

		Inner 50 Feet			
Outer 50 Ft		**Poor**	**Marginal**	**Suboptimal**	**Optimal**
	Poor	Poor	Marginal	Marginal	Suboptimal
	Marginal	Poor	Marginal	Suboptimal	Suboptimal
	Suboptimal	Poor	Marginal	Suboptimal	Optimal
	Optimal	Marginal	Suboptimal	Suboptimal	Optimal

Table 2: Riparian Buffer Conditions for the Left and Right Banks

		Left Bank			
Right Bank		**Poor**	**Marginal**	**Suboptimal**	**Optimal**
	Poor	Poor	Poor	Marginal	Marginal
	Marginal	Poor	Marginal	Marginal	Suboptimal
	Suboptimal	Marginal	Marginal	Suboptimal	Optimal
	Optimal	Marginal	Suboptimal	Optimal	Optimal

IN-STREAM HABITAT

<u>High Gradient Streams – Habitat Elements:</u> moderate-high gradient landscapes; substrates composed of coarse sediments [gravel (2mm) or larger] or frequent coarse particulate aggregations; riffle/run prevalent.

- A varied mixture of substrate sizes (i.e., sand, gravel, cobbles, and boulders).
- Low amount of highly mobile substrate material.
- Low Embeddedness of substrate material (Observations of embeddedness should be taken in the upstream and central portions of riffles and cobble substrate areas.)
- A varied combination of water velocities and depths (riffles and pools) - More combinations of velocity and depth patterns provide increased habitat diversity.
- The presence of woody and leafy debris (fallen trees, logs, branches, leaf packs, etc.), root mats, large rocks, and undercut banks (below bankfull).
- The provision of shade protection by overhanging vegetation.

A diverse and abundant assemblage of these features promotes the potential for colonization by diverse and abundant epifaunal and fish communities.

POOR: Conditions are generally unsuitable for effective epifaunal colonization and/or fish cover. A stream is considered to provide *Poor* in-stream habitat if any of the following conditions exist:

4. Substrate is homogeneous, highly mobile, or highly embedded (greater than 75%);

5. Little variability or combinations of water velocity and depth patterns;
6. Habitat elements are lacking or are unstable. Habitat elements are typically present in less than 20% of the reach.

MARGINAL: Conditions are less than desirable, but generally suitable for at least partial colonization by a moderately diverse and abundant epifaunal community. Potential fish habitat is present, but is not abundant and does not occur evenly throughout the stream reach. *Marginal* in-stream habitat is present if the following conditions exist:

4. The substrate is comprised of a variety of substrate particle sizes, some of which are mobile and some of which are not highly mobile, and are moderately embedded (25 – 75%);
5. There is a combination of water velocity and depth patterns;
6. Habitat elements listed in the parameter guidelines are present, but are not plentiful or distributed evenly throughout the reach. Habitat elements are typically present in 20 – 70% of the reach and are adequate for maintenance of populations.

OPTIMAL: Substrate is favorable for colonization by a diverse and abundant Epifaunal community, and there are many suitable areas for Epifaunal colonization and/or fish cover. *Optimal* habitat is present if the following conditions exist:

4. The substrate is comprised of a variety of substrate particle sizes that are neither highly mobile nor embedded (less than 25%);
5. There is a combination of water velocity and depth patterns;
6. The majority of habitat elements listed in the parameter guidelines occur frequently and are distributed evenly throughout the reach. Habitat elements are typically present in greater than 70% of the reach.

2. Low Gradient Streams – Habitat Elements: low-moderate gradient landscapes; substrates of fine sediment particles or infrequent aggregations of coarse sediment particles [gravel (2mm) or larger]; glide/pool prevalent.

- A varied mixture of substrate materials (i.e., sand and gravel) in pools – Varied substrate materials support a higher diversity of organisms than mud or bedrock;
- Submerged aquatic vegetation in pools – Will also support a higher diversity of organisms;
- The presence of woody and leafy debris (fallen trees, logs, branches, leaf packs, etc.), root mats, and undercut banks (below bankfull)
- The provision of shade protection by overhanging vegetation.

A diverse and abundant assemblage of these features promotes the potential for colonization by diverse and abundant epifaunal and fish communities.

POOR: Conditions are generally unsuitable for effective epifaunal colonization and/or fish cover. A stream is considered to provide *Poor* in-stream habitat if:

4. Pool substrate composed primarily of hard-pan clay or bedrock;
5. No rootmat or submerged vegetation in pools;
6. Habitat elements listed in the parameter guidelines are lacking or are unstable. Habitat elements are typically present in less than 10% of the reach.

MARGINAL: Conditions are less than desirable, but generally suitable for at least partial colonization by a moderately diverse and abundant epifaunal community. Potential fish cover is present, but is not abundant and does not occur evenly throughout the stream reach. *Marginal* in-stream habitat is present if:

1. Pool substrate composed of mud, sand, or clay;
2. Some rootmat or submerged vegetation may be present in pools;
3. Habitat elements listed in the parameter guidelines are present, but are not plentiful or distributed evenly throughout the reach. Habitat elements are typically present in 10 – 50% of the reach and are adequate for maintenance of populations.

OPTIMAL: Substrate is favorable for colonization by a diverse and abundant Epifaunal community, and there are many suitable areas for epifaunal colonization and/or fish cover. *Optimal* habitat is present if:

4. Pool substrate composed of a mixture of substrate materials, with gravel and firm sand prevalent;
5. Rootmat and submerged vegetation common;
6. The majority of habitat elements listed in the parameter guidelines occur frequently and are distributed evenly throughout the reach. Habitat elements are typically present in greater than 50% of the reach.

CHANNEL ALTERATION

Examples:

Stream crossings
Riprap along streambank or in streambed
Embankments on streambanks
Concrete, gabions, or concrete blocks along streambank
Straightening of channel
Constrictions to stream channel or immediate flood prone area

SEVERE: Greater than 80% of reach is disrupted by any of the channel alterations listed.
Note: Portions of the assessment reach that are within a culvert or bridge receive a Parameter Condition of *Severe*.

MODERATE: 40 - 80% of reach is disrupted by any of the channel alterations listed.

MINOR: Some of the reach is disrupted by any of the channel alterations.

NEGLIGIBLE / NONE: Disruptions by any of the channel alterations listed in the parameter guidelines are absent or minimal. Stream has an unaltered pattern, or a pattern that has "re-normalized."

POINTS PER PARAMETER CONDITION

Channel Condition	Riparian Buffer	In-Stream Habitat	Channel Alteration
Severe (0)	Poor (0)	Poor (0)	Severe (0)
Poor (0.5)	Marginal (0.5)		Moderate (0.3)
Marginal (1.3)		Marginal (0.8)	
Suboptimal (2.0)	Suboptimal (1.1)		Minor (0.7)
Optimal (2.5)	Optimal (1.5)	Optimal (1.5)	Negligible (1.0)

STREAM QUALITY FACTOR

RCI Conversion to SQF

SICAM RCI	SAAM RCI	Stream Quality	Stream Quality Factor (SQF)
0.5-0.7	0.00-0.28	*Severe*	1.0
0.8-1.7	0.29-1.12	*Poor*	1.1
1.8-3.7	1.13-3.00	*Marginal*	1.2
3.8-5.7	3.01-4.87	*Suboptimal*	1.3
5.8-6.7	4.88-5.71	*Optimal*	1.5
6.8-7.0	5.72-6.00	*Exceptional*	1.6

Appendix F

Success Criteria

DEQ regulation (9 VAC 25-210-80) states that final compensatory mitigation plans must include success criteria, among numerous other requirements. Therefore any project completed for the purpose of compensating for stream impacts must have success criteria applied to it. This section describes success criteria which may be applied to any project that is completed for the purpose of fulfilling **Total Compensation Requirements** (**Total CR**) (i.e. compensating for stream impacts using the methods described in this Manual). These success criteria may be applied to on-site and off-site compensation projects completed for a specific permit, stream banks, and in-lieu fee fund projects. The development and application of a consistent set of success criteria fosters consistent implementation of requirements for stream restoration activities undertaken through these various compensation alternatives.

The application of success criteria to stream compensation projects serves two primary purposes: 1) as a measure of success for achieving the stated goals and objectives of the project; and 2) as an important aid in determining if corrective action is warranted. Other purposes and benefits include evaluating short-term vs. long-term success, evaluating the various restoration activities employed using the Compensation Categories described in Section 4.1, and enabling data collection and analysis of the measured parameters for continued improvement.

These success criteria contain seven different parameters used to judge success and to determine if corrective action is warranted. These seven parameters are Riparian Buffer, Stream Reach Stability, Dimension, Pattern, Profile, Structures, and Habitat or Macro-Invertebrates. Each parameter contains a qualitative statement that describes the desired condition of that parameter. Each then states measurements and criteria DEQ will use to aid in determining whether that condition is met. The selection of specific success criteria for each project is tailored to the goals & objectives of that project. The selection should be based on certain project specific information such as the type of restoration activity or Compensation Category, the current stream condition vs. the anticipated restored condition, the stream type being restored, and the stream type being created. Continued application of these succes criteria may reveal a correlation between this information and the selected success criteria.

It is important to note that this is not a standard set of success criteria to be placed on <u>all</u> projects. It is a set of success criteria to <u>choose from</u>. Not all projects require all of these success criteria; however projects considered to be in the Restoration category would likely receive most, if not all, of the listed success criteria. Additionally, the agency representative may also choose to apply other success criteria not specifically listed in this Manual if project specifics warrant it. However, it is imperative that the selected success criteria are comprehensive enough to analyze the departure from the approved as-built condition since the approved as-built condition is used as a comparison for all future monitoring events. It is also imperative that the selected success criteria be repeatable and reproducible to allow year-to-year comparisons to show departure, problems, and enable analysis of data over time.

As stated above, one of the primary purposes of success criteria is to serve as an important aid in determining if corrective action is warranted. Corrective action is warranted when the goals & objectives stated in the approved Final Compensation Plan are not being met. The success criteria aid in making this determination, as does best professional judgment. As these success criteria are increasingly applied to stream compensation projects, the data gathered and information accrued may lead to modifications that make them more appropriate. For this reason, best professional judgment is also used in determining whether or not the success criteria are met and whether corrective action is warranted. Therefore, the "General Success Criteria Statement for all Projects" located at the end of the success criteria should be included in every Final Compensation Plan in addition to the selected success criteria.

DEQ's development of stream restoration success criteria began in 2002. Since that time, the criteria have been modified and been applied to stream compensation projects and banks throughout the state. DEQ has presented them and received comments on two separate occasions from members of the Virginia Stream Alliance, distributed them and received comments from members of DEQ's Stream Mitigation Advisory Workgroup, and presented these Success Criteria at the 2005 Mid-Atlantic Highlands Stream Restoration Workgroup Annual Conference.

Success Criteria

Riparian Buffer

1. A minimum of 400 woody stems of native trees and shrubs per acre (including volunteers) from the top of the bank and landward shall be achieved by the end of the third growing season following planting and maintained each monitoring year until canopy coverage is 30%. Canopy coverage shall be at least 30% each monitoring year thereafter. (The number of woody stems per acre may vary under certain circumstances. For example, if invasive species need to be controlled upon implementation of the project, then a lower density may be appropriate in order to mow and/or spray).

2. Herbaceous plant coverage shall be at least 60% by the end of the first growing season, and at least 80% each monitoring year thereafter.

Stream Reach Stability

The analysis of the streambank from the top of the bank to the channel shall indicate a significant amount of natural protection to prevent streambank erosion that could jeopardize the stability of the streambank or the stream reach.

The following measurements will be used to aid in making this determination each monitoring year:

A. The number of live stakes and planted or volunteer woody species providing bank stabilization from the top of the bank to the channel shall be at least 1 living stem per 10 square feet by the end of the first growing season following planting and maintained each monitoring year until canopy coverage is 50%. Canopy coverage shall be at least 50% each monitoring year thereafter.

B. The individual Index Values of the Bank Erodibility Hazard Index (BEHI) rating shall be equal to or less than the previous year's Index Value. In addition, the Total Score shall be less than the previous year's Total Score, and shall have a Total Score of "Moderate" by Monitoring Year 3, and a Total Score of "Low" by Monitoring Year 5, and maintained at "Low" throughout the remainder of the monitoring period.

C. The U.S. Forest Service Stream Reach Inventory and Channel Stability Evaluation (Pfankuch, 1975) rating shall be "Good" each monitoring year.

Dimension

The analysis of each permanent riffle cross-section shall indicate that it has neither aggraded, degraded, widened, or narrowed to the point where it has become unstable or will cause instability.

The following measurements will be used to aid in making this determination each monitoring year:

A. The Width / Depth Ratio Stability Rating (measured Width / Depth Ratio divided by the as-built Width / Depth Ratio) shall not be greater than 1.3. If the channel is incising, then the Width / Depth Ratio Stability Rating shall not be less than 0.7.

B. The Bank Height Ratio shall not increase or decrease by an amount greater than 0.2 of the as-built Bank Height Ratio.

C. Other measurements to consider include:
   - Cross-sectional area

Pattern

The analysis of the plan-view survey or field measurements shall indicate that the stream is not migrating significantly to the point where it has become unstable or will cause instability

The following measurements will be used to aid in making this determination each monitoring year:

A. The Radius of Curvature / Width Ratio shall remain within the range of variability present in the reference data.

B. The analysis of Vertical Bank Profiles and/or Bank Pin surveys shall not indicate significant movement of the streambank or significant amounts of erosion.

C. Other measurements to consider include:
   - BEHI ratings used to determine Stream Reach Stability
   - Near Bank Stress measurements relative to BEHI ratings on the outside of meanders

Profile

The analysis of the longitudinal profile shall indicate that the bed elevation has neither aggraded nor degraded to the point where it will cause instability.

The following measurements will be used to aid in making this determination each monitoring year:

A. The analysis of the Longitudinal Profile shall not indicate significant alterations in the locations and slopes of stream features (riffle, run, pool, glide).

B. The slope of the longitudinal profile shall not increase or decrease by an amount greater than 0.3% of the as-built slope.

C. The analysis of Scour Chain surveys shall not indicate significant aggradation or degradation of the streambed.

D. Bankfull Shear Stress, and Mean Depth and Slope (calculated using Critical Dimensionless Shear Stress) shall be appropriate for transporting the D_{100} of either the bar sample or the sub-pavement sample.

Structures

The analysis of each instream structure shall indicate that it is maintaining its structural integrity, performing its intended function, and not adversely affecting the stream.

The following measurements will be used to aid in making this determination each monitoring year:

A. The elevation of the flow invert and header rocks of any vane, j-hook, cross-vane, or W-weir shall remain unchanged from the as-built.

Habitat or Macro-Invertebrates (used primarily for complex projects with instream work)

The analysis of instream habitat and macro-invertebrates shall indicate that conditions suitable for supporting diversified macro-invertebrate communities have improved or are improving.

The following measurements will be used to aid in making this determination each monitoring year:

A. Instream habitat and/or macro-invertebrate index values shall indicate an improvement from the pre-existing condition, and shall be equal to or better than the previous year's values.

B. Instream habitat and/or macro-invertebrate index values shall be at least 50% of the value taken from an appropriate reference reach by Monitoring Year 2, and shall be 75% by Monitoring Year 5 and maintained throughout the end of the monitoring period.

General Success Criteria Statement for all Projects

To determine the success of the stream restoration, best professional judgment will be used while observing site conditions **and** reviewing the monitoring results. Variance from the success criterion does not automatically require corrective action, as adherence to the success criterion may require corrective action under certain circumstances. Visual observations and a review of the entire stream system will be analyzed to determine if the system is stable or unstable, and if corrective action is warranted.